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THREE-HINGED CONCRETE ARCH BRIDGE, BROOKSIDE PARK, CLEVELAND, O.

By H. F. Hackedorn.*

The concrete bridge that has just been completed and opened for traffic over Big Creek, in Brookside Park, Cleveland, O., enjoys the distinction of being the first three-hinged concrete arch bridge that has ever been constructed in this country, and also of being the flattest semi-elliptical arch ever constructed. It is a plain concrete arch without longitudinal reinforcement, with a rise of less than one-tenth of the span, and with steel hinges (Fig. 1) at the crown and haunches to take up any arch ring movement. The lines of the bridge are graceful without any sacrifice of strength.

The care used in the designing of the bridge, which is a perfect semi-ellipse, was clearly proven at the time the centers were struck, by the almost entire absence of any deflection when all false work was removed; the last of the upright posts in the centering were as easily knocked out with a sledge hammer as the first ones that were removed, thereby proving that the arch had taken all of its own strains before the centers were struck. This last fact is exceptional in a concrete arch where the false work is removed in extreme cold weather, because the concrete is in its extreme contraction, on account of the cold, and if there could ever be any strain on the centering, it would surely occur at that time, but in this bridge the deflection at the crown was only 0.05 in. greater than was computed for temperature variations, shrinkage of the concrete due to setting in air and the shortening due to axial compression.

In construction the engineers of the Park Department have departed somewhat from precedent. At no other place in the world we are advised, has a semi-elliptical concrete arch been constructed as flat as this one without heavy steel reinforcement, and the result is certainly a very great compliment to the engineer who designed the bridge.

The concrete, composed of Portland cement, crushed stone and silicious lake sand, was made a little richer in cement than is usual in bridge work, and each batch was very thoroughly mixed, promptly placed in the forms and thoroughly tamped in place, thereby securing the very best that can be gotten out of Portland cement concrete. In placing the concrete each integral part of the arch was put in continuously, without stopping the work, in one day; one abutment was built up to the hinge in a day and then one-half of the arch proper was built the next day, and so on until the work was entirely completed. It required some pretty long days on the part of the contractors and much of the work was put in under artificial light, long after darkness had settled down, but the result has amply repaid the builders by the excellence of the work secured and the absolute security in point of safety. The only steel reinforcement that was used in the bridge was some short small rods that were placed as a tie between the arch proper and the spandrel walls to prevent any possibility of the walls spreading when the earth fill was placed on the bridge.

It is a well known fact that concrete shrinks not a little when permitted to set in air. Fearing that this shrinkage, together with a fall in temperature and the axial stress were sufficient to crack the arch, even though the abutments (which were built into and rest upon solid shale) were perfectly rigid, it was decided that the safest, as well as the cheapest, way was to make it three-hinged, giving it thus perfect freedom to adjust itself to all conditions.

The hinges were built up of plates, angles, steel shafting and cast iron bearing plates, as shown by the drawings of Fig. 2. The bearing plates were carefully fitted to the steel shafting so as to make a uniform bearing on the shaft, and before being placed in position were carefully greased and the joints all protected by a thick coating of tallow, to prevent the water from reaching the bearing and causing it to rust. The concrete opposite each hinge is entirely separated about ½ in. and this opening is again closed by a carefully placed calking of pure asphalt, which will protect the hinges from water, but at the same time will allow a deflection if the temperature should, at any time, render such action necessary. These hinges weigh more than 10,000 lbs., and are so completely imbedded in the concrete as to prevent any slipping or change of position by any exterior cause. The use of the hinges was well demonstrated when the centers were removed. By observations, immediately before and after removing the centers, it was found that the drop at the crown of the arch was 1½ ins., an amount sufficient to crack the concrete, had it not been for the hinges.

The building of the false work to support the concrete in place while it was setting, was no small part of the expense of the construction, as it was necessary to build it so that it would be absolutely unyielding in every direction, and strong enough to carry the weight of the arch itself, amounting to nearly 1,000,000 lbs. exclusive of ths hinges, but this was so carefully computed that there was no appreciable settlement when the concrete was placed on the timbers.

THREE-HINGED CONCRETE ARCH BRIDGE, BROOKSIDE PARK, CLEVELAND, OHIO.
(The iron railing had not been placed when this photograph was taken.)

In order more thoroughly to protect the concrete from the action of water and frost, the entire top of the arch was carefully covered at completion with a heavy waterproof coating of asphalt gum, thus preventing the seepage of water into the concrete and the resulting danger of freezing. For the same reason all of the outside exposed faces of the arch have a 2-in. coating of very rich concrete mortar that was put on at the same time as the body of the concrete, thus guaranteeing an absolute bond between this facing and the main body of the work. The concrete is a 1:2½:5 mixture.

The shape of the arch is in appearance that of a semi-ellipse, whose major axis is 92 ft. and semi-minor axis, 9 ft. The arch proper, however, stops at the abutment hinges. The true rise is the vertical distance between the center of the abutment hinges and that of the hinge at the crown, or 5 ft. 2½ ins., and the span is the distance from center to center of abutment hinges which is 86 ft. 4½ ins., making thus a ratio of rise to span of about 1 to 16½.

The position of the hinges being so chosen that there will be no tension in any portion of the arch, even with an unsymmetrical live load, it was deemed unnecessary to incur the extra expense of steel reinforcement, as the designer believed it poor designing to place steel in concrete,

*Block Bridge & Culvert Co., Indianapolis, Ind.

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INJURIES BY EARTHQUAKE TO THE BUILDINGS OF STANFORD UNIVERSITY.

Newspaper reports of the earthquake damage to the Stanford University buildings have generally represented the majority of the structures as practically demolished. We are glad to be able to present below an official statement showing that the damage to these buildings is very much less than has been hitherto reported.

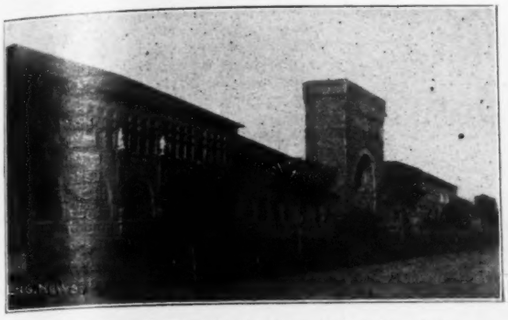


Fig. 1. Front Facade Stanford University, Outer Quadrangle, Before Earthquake of April 18.

FIG. 2. MEMORIAL ARCH, STANFORD UNIVERSITY, AFTER EARTHQUAKE OF APRIL 18.

REPORT OF THE STANFORD UNIVERSITY ENGINEERS ON THE INJURIES TO THE CLASS ROOMS AND LABORATORIES FROM THE EARTHQUAKE OF APRIL 18, 1906.

After a careful examination of the buildings used for university purposes, including Roble and Encina Halls, we find that the damage from the recent earthquake is much less than was anticipated.

The buildings of the inner quadrangle, the one-story buildings of the outer quadrangle (with one exception), the Zoology Building, the Physiology Building, the Assembly Hall, the Library, the old Engineering Building, the Machine Shop, the Foundry and the Mechanical Laboratory are substantially intact and can be used after a few minor repairs.

The four corner two-story buildings and the small one-story Physics Building of the outer quadrangle, the Forge Shop, the Woodworking Shop, and the Chemistry Building will require partial rebuilding of some of the walls.

In Encina Hall the south walls of the east and west wings will require partial reconstruction, also those portions injured by the two falling stone chimneys. The fall of one of the chimneys, which tore through the floors to the basement, caused the death of one student. Aside from the damage noted above, the building as a whole is uninjured and perfectly safe.

The damage to Roble Hall is confined to the two holes torn in the floors by the falling chimneys. The remainder of the building shows practically no evidence of having passed through an earthquake.

In the opinion of the Committee, such of the buildings mentioned above as are necessary for carrying on the university work can easily be made ready for occupancy and safe use in time for the opening of the University on August 23.

Our full and detailed examination of the buildings from foundation to roof shows that the actual damage to their stability is less than might be inferred from external appearances.

Signed by the Committee:

Charles B. Wing, Structural Engineer.
William F. Durand, Mechanical Engineer.
Arthur B. Clark, Architect.
Charles E. Hodges, Architect.
Charles D. Marx, Civil Engineer, Chairman.

A feature of particular interest to engineers is the condition of the reinforced concrete buildings at the University. These buildings were erected 13 years ago and the reinforcement was confined, we believe, to the floors, the work being among the earliest of Mr. Ernest L. Ransome with his now well-known twisted rod reinforcement.

We append below a detailed statement furnished by Prof. Wing at our special request showing the nature of the damage to specific buildings, and accompanied by photographs. It will be seen from this statement that the two concrete buildings, notwithstanding the fact that their design and construction would nowadays be considered extremely crude, came through the earthquake in excellent shape.

STATEMENT BY PROF. CHAS. B. WING.

The buildings of Stanford University are arranged to form what are known as the inner and outer quadrangle. The inner quadrangle is composed of twelve one-story buildings of varying sizes arranged around the sides of a rectangle, four on each side and two at each end.

In the center of each end is a masonry arch about 30 ft. high and 15 × 30 ft. in plan. In the center of one side of the rectangle is the Memorial Church and opposite it on the other side is a series of three large arches forming part of the general entrance through the memorial court to the inner quadrangle and church entrance.

The buildings of the inner quadrangle are surrounded by larger two-story buildings. Two on each side of the large memorial arch with an L building on each corner form the front façade of the outer quadrangle. Two small one-story buildings on each end with two-story L buildings on each corner form the remainder of the outer quadrangle. A line of one-story buildings parallel to the quadrangle with two detached buildings and a tall chimney at the back are used for laboratory shop and power purposes.

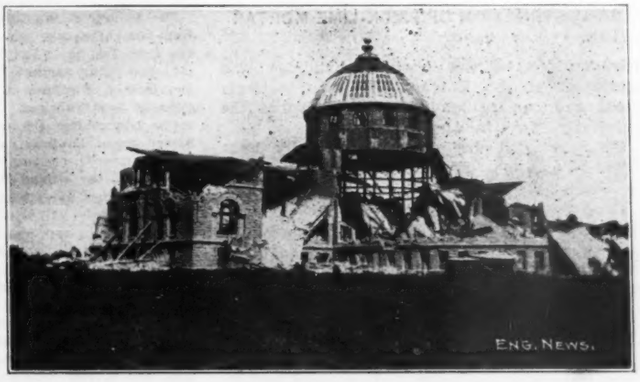


FIG. 4. REAR VIEW OF LIBRARY BUILDING (IN COURSE OF CONSTRUCTION), AFTER EARTHQUAKE, SHOWING STEEL TOWER. GLASS IN DOME UNBROKEN.

In front of and in a line parallel to the ends of the quadrangle are, on the west, the three-story chemistry building and the two-story museum buildings separated from the quadrangle and each other by some 500 ft. Opposite these buildings to the east are the library building and gymnasium in process of construction.

In line with the front of the quadrangle about 1,000 ft. away and facing in the same direction are the two dormitories, on the west Roble hall, a three-story building for women, and on the east Encina hall, a four-story building for men.

The buildings and arches of the inner quadrangle, with the exception of the church, are substantially intact, the damage consisting principally of loose plaster. The church was badly damaged by the tower falling through the roof and the falling of the gable of the organ loft.

The photograph shows the main tower supported by steel still standing. The spire and clock faces were supported by timber resting on the walls with insecure fastenings. These timbers spread, carrying with them considerable masonry and caused the break in the roof shown in the photograph. The end gable was not securely fastened to the roof, and consequently fell.

In the outer quadrangle the memorial arch is badly damaged, and the four corner buildings are

FIG. 3. GENERAL VIEW OF QUADRANGLE AFTER EARTHQUAKE.

where the concrete is actually in compression. If we allow a maximum compressive strain of 500 lbs. per sq. in. on the concrete, the steel would only take about 5,500 lbs. This would be poor economy.

The diagonal distance from the center of the abutment hinge to the center of the hinge at the crown is 43 ft. 6 ins. and the horizontal distance is 43 ft. 2¼ ins. Assuming the shrinkage of the

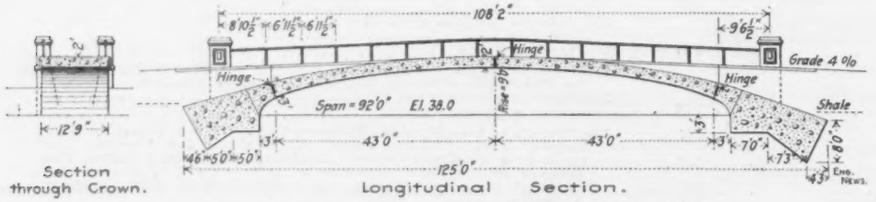


FIG. 1. SECTIONS OF THREE-HINGED CONCRETE ARCH BRIDGE.

concrete equivalent to a unit compression of 4,000 lbs. per sq. in. on steel, which is a good average from numerous tests, the shortening due to the compressive stress, which we assume to be about 250 lbs. per sq. in. as an average, and the difference in temperature between time it was built and the time when centers were struck, to be about 28° F., we would have a total shortening in half the arch of .015 ft. From this we find the drop at the crown to be 1.45 ins.

The bridge was designed by A. W. Zesiger, Assistant Park Engineer of the city of Cleveland, and was built by the Block Bridge & Culvert Co., of Indianapolis, Ind.

A NEW INSULATING COMPOUND.

A new material for electrical insulating purposes known as "Voltax" has recently been placed on the market, and is coming into extensive use. The material appears to be a hydro-carbon, but is claimed to be less easily melted than the other hydro-carbons in use for insulation. It has been used in a limited way for seven years past, so that its capabilities are well established by practical experience, and arrangements have just been made for its manufacture on a large scale.

The Electrical Testing Laboratories of New York have tested samples of No. 6 B. & S. wire insulated by "Voltax" with the following results: one sample, insulated with one layer of impregnated tape, was subjected to an alternating current and punctured first at 2,500 volts, while some samples ran as high as 70,000 volts before breakdown occurred. Samples with two layers of tape varied between the limits of 4,000 and 10,000 volts, four layers gave the limits 22,500 and 30,000 volts, while a sample covered with six layers, after being immersed in salt water continuously for 72 hours, punctured at 23,000

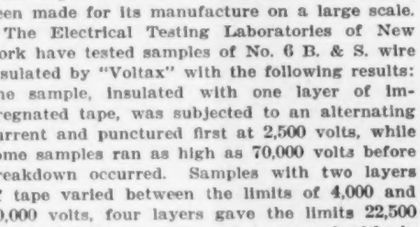


Fig. 2. Details of Hinges for Concrete Arch Bridge.

volts. These samples after being punctured were then subjected to a carrying capacity test. Alternating current at ten volts was applied, the current being gradually increased from 50 amperes to 130 amperes when, 46 minutes after the current was turned on, one sample showed the first signs of moisture. After the current had risen to 200 amperes, the sample having carried current for 64 minutes, the compound dripped freely. The samples with one layer and four layers of tape were then again subjected to the puncture test, when the sample with one layer gave the limits of 2,000 and 2,100 volts, while the sample with four layers varied between 16,000 and 16,300 volts. The insulation resistance of a sample of wire covered with six layers of impregnated tape after being soaked in salt water for 72 hours was 500,000 megohms on 600 volts. This figure is only approximate since the resistance is so high, but indicates that the resistance is of the order of several hundred megohms. Sheets of the compound were also tested for puncture and insulation resistance. Sheets of 75 mils thickness punctured between the limits of 20,000 and 25,000 volts, while sheets of 105 mils thickness punctured at 30,000 volts. In making the resistance tests it was found that the resistance was too high to be measured. While the compound appears to burn as readily as rubber or other compounds, it is peculiar in that the tape does not appear to be greatly harmed after the blaze is extinguished, the compound simply burning off, leaving the tape intact.

The advantages which the makers of "Voltax" claim for it over other forms of insulation are stated as follows in a publication issued by the company:

> It costs 20% less than ordinary rubber insulation; is a neutral compound absolutely impervious to atmospheric conditions; retains its elasticity and insulating properties for an indefinite time; is not subject to chemical change as is rubber and all other insulations; is absolutely water, acid and alkali proof and will not drip under 200° F.; may be subjected to severe tension, and bent at short angles without in any way effecting the insulation; can withstand a voltage 100% greater than a rubber insulation; has successfully stood high potential, insulation, resistance and melting point tests that no other insulating material yet discovered has withstood; has absolutely no injurious effect on copper and hence does not require the tinning of the copper before applying the compounds, as there is no corrosive action whatever.

It is also claimed that a superior way of laying underground cables is to dig a trench about 18 ins. deep, in which a wooden box of the required dimensions is laid with the required porcelain insulators placed in this box. After the wire is in place the box is filled with "Voltax" compound, thus surrounding the wires with an insulation which will not crack and cause a leak to earth or between conductors, thereby doing away with all expense for maintenance. It is stated that, by thus wiping out the annual maintenance charge which must be borne by conduit systems, several extra wires can be laid for future expansion at a less cost than a corresponding number of extra ducts. The cost of a complete system installed in this manner will be less than two-thirds the cost of a corresponding conduit system.

In manufacturing "Voltax" wire and cable, strips of cotton tape impregnated with the compound are wound around the copper cable, the number of layers of tape applied and the composition of the compound, which is a secret, being varied according to the voltage and climatic conditions to which the finished wire or cable is to be subjected. After the impregnated tapes have been applied to the conductor they are covered with one or more jute braids, to facilitate handling and to protect the tape from mechanical injury.

The Electric Cable Co. has just completed a new factory at Bridgeport, Conn., for the manufacture of "Voltax" cables, conductors, wires and compound, also field and armature coils and soldered mesh rail bands.

THE MILAN EXHIBITION.

The international exhibition to be held at Milan, Italy, this year, differs from most exhibitions of this kind, in that it celebrates a recent achievement in engineering instead of a past event of general historical importance. It was organized in connection with the celebration of the opening of the Simplon Tunnel, which great work is of special importance to Italian commerce, and for this reason the exhibition has been made more especially one of means of transportation. The main part of the exhibition is on the Piazza d'Armi, the parade ground of the local garrison, 1½ miles from the center of the city. The smaller section, containing the more ornamental and entertainment features, is in a portion of the Sempione Park, close to the amphitheater in which special contests, etc., will be held. The distance between the two sections is about half a mile, and an elevated electric railway has been built to connect them. The exhibition is within easy walking distance from the center of the city, and is reached by a number of electric street car lines, which have been extended for this purpose. The area of the exhibition is not sufficient to require any special means of intramural transportation. One of the main buildings is of steel frame construction, but in general the construction is of wood, and is reported to be of rather light design, even for temporary structures; this is due to the scarcity and high cost of timber. The exterior covering and decorative work are of the "staff" or plaster composition first used for the Chicago Exhibition of 1893, and the buildings are said to be very handsome in design. A high tower, fitted with elevators, provides for a general view of the exhibition and its surroundings. Mr. C. Mangili is President of the Executive Committee, and Mr. Giovanni Giachi is Engineer and Chief of Works.

The exhibits of the Department of Land Transportation and Aeronautics are classified as follows: 1, Roads and streets; 2, Vehicles for land transportation; 3, Cycles; 4, Automobiles; 5, Railways (exclusive of electric traction); 6, Electric transportation by land; 7, Means of handling freight and baggage; 8, Aeronautics; 9, Mail, telegraph and telephone service; 10, the Simplon tunnel and railway; 11, Metrology, and apparatus and instruments for measurements of all kinds. The Simplon Tunnel exhibits include full-size models of the tunnel cross-section, and examples of the drills and other machinery; also drawings, models and photographs of the tunnel works, surveys, power plants, etc. The exhibits of the Department of Marine Transportation are divided into ocean and inland navigation. The former are subdivided into shipbuilding, harbors and dockyards, navigation, warships and naval equipment, fishing craft and apparatus, and life-saving boats and apparatus. The inland navigation section is subdivided into canals, river improvements, bridges and locks, vessels and mechanical tonnage or propulsion, and naval engineering service.

In addition to the transportation sections, there will be exhibits of naval and military engineering, agriculture and agricultural machinery, industrial arts, sanitation and hygiene, etc. Special buildings have been erected by Austria, Belgium and France. A number of prizes for exhibits of special character have been offered by the King of Italy and the Italian Manufacturers' Association, as follows: 1, Protection of electrical workmen from high-tension currents; 2, New machines or processes of practical value; 3, Automatic car couplers; 4, Providing pure milk in thickly populated centers; 5, Design for plain buildings suitable to the climate of southern Italy; 6, Motor boats; 7, Prevention of accidents by contact between primary and secondary windings in alternating-current transformers; 8, Lowering loads by hand cranes or winches without causing the handles to revolve; 9, Stopping trucks on inclined planes in the event of breakage of the hauling rope; 10, Collection of dust from the sorting of rags, the carding of flax and hemp, and the manufacture of cement.

In connection with this exhibition the biennial meeting of the International Street Railway and Light Railway Congress will be held at Milan in September. This organization bears the same relation to street and interurban railways that the International Railway Congress bears to the steam railways of the world. The list of subjects to be discussed has already been given in our columns.

badly shaken, some of the walls falling and other portions requiring rebuilding. The floors and interior structure, aside from falling plaster, show but little signs of disturbance, and reconstruction of portions of the outer walls will put these buildings in condition for use. The damage to the chemistry building is of a similar character to

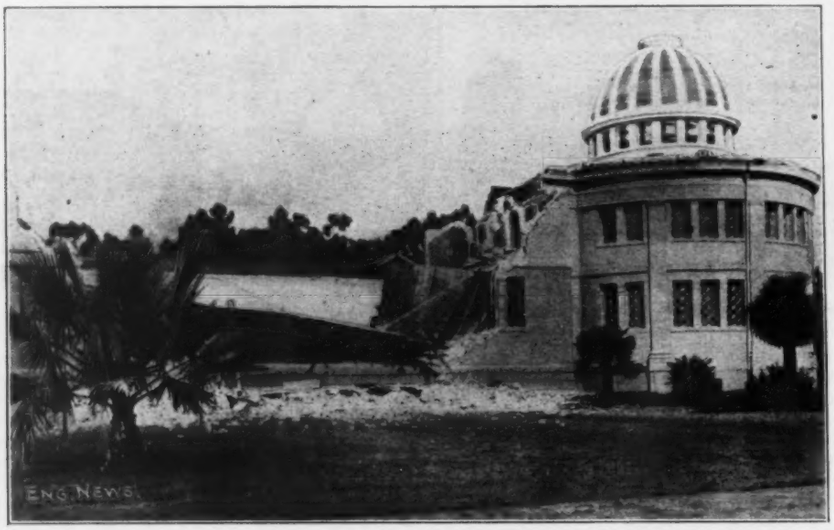


FIG. 5. MUSEUM, STANFORD UNIVERSITY, SHOWING DESTRUCTION OF BRICK-LIME MORTAR CONSTRUCTION.

that of the buildings of the outer quadrangle. Portions of the museum, the library building (in process of construction) and the gymnasium (nearing completion) are badly wrecked.

The buildings of the inner quadrangle, with the exception of the church, were built some fifteen years ago under careful inspection, by day labor, of quarry-faced sandstone backed with rubble. As far as can be determined by external inspection, the walls are well bonded and the quality of the mortar is excellent.

The church and other buildings of the outer quadrangle recently built are constructed of the same sandstone backed by brick. The stone work consists of a veneer not less than 4 ins. thick, with no bond to the brick.

The corner buildings of the outer quadrangle have no roof trusses, the inclined rafters merely resting on the wall plates. As might have been expected, the walls of these buildings were badly damaged. The museum buildings consist of the original building of concrete with wings of plastered brick of recent construction. The construction of the original building was described and illustrated in Engineering News, 1893, I, 162, and is undamaged. The library and gymnasium have heavy brick walls (4 ft. thick in some cases) veneered with stone. These have been badly demolished, as shown by the photographs. The central dome of the library supported by steel is undamaged, not a pane of glass being broken.

Roble hall, the women's dormitory, is a monolithic concrete structure. The only effect of the earthquake on this building was to throw down two chimneys, which broke through the roof and two upper floors. Fortunately, the occupants of the rooms underneath escaped injury.

Encina hall, the men's dormitory, is four stories high and built of masonry. A heavy chimney broke through the roof, tearing through the successive floors to the basement and causing the death of one student. The gable walls of the wings of this building were also badly cracked. Otherwise this building is substantially intact, due in large measure to well-designed wooden roof trusses and good workmanship in the masonry.

The only death, aside from the one mentioned above, was due to the fall of the heavy masonry chimney at the end of the power-house. This chimney was twisted off some 20 ft. from the ground and fell in two directions, the top falling south and the central portion north, the latter crashing through the corner of the boiler room and crushing one of the firemen.

The mechanical laboratory and machine shop were not damaged, and the latter is already in operation. The woodworking shop and foundry will require some repairs to the outer walls.

The damage to the working buildings and equipment of the University is comparatively slight and can be readily repaired before the University opens in August.

Buildings well designed and carefully built either of masonry, concrete or steel, have stood the shock remarkably well.

The necessity of providing strong roof trusses, secure anchorage of gables to roof and thorough bonding of masonry walls is everywhere apparent, but after all this means nothing more than good design and good workmanship.

A REPORT BY EDWIN DURYEA, JR., ON EARTHQUAKE DAMAGES AT SAN FRANCISCO AND PALO ALTO.

Sir: The principal structural lesson that can thus far be drawn from the earthquake is that any type of building construction—steel, brick, stone, concrete or wood—which was well designed and thoroughly and honestly constructed stood the shock with very little damage resulting to it. This was well exemplified in the buildings of Stanford University. They were carefully examined after the earthquake by a committee of engineering professors and I have also personally gone over many of them since then. Nearly all the damage is due to a combination of three causes: (1) Absence of trusses in roofs, allowing a settling of rafters and a consequent shoving out of side walls; (2) insufficiently supported gables; and (3) poor masonry, having voids imperfectly filled with mortar, weak lime mortar, entire absence of bond between the facing-stones and the brick backing and showing convincing evidence that neither brick nor stones were wet before laying.

The buildings at Stanford are divided into two general classes—the working buildings, mainly built some years ago by day labor, and the ornamental buildings (chapel, gymnasium, library, museum, etc.), built later by contract, with no engineering and very little architectural supervision. With rather unimportant exceptions, the damage was confined to the latter class. The line was so sharply drawn that the main body of the museum, carefully built of reinforced concrete some 15 years ago, was almost uninjured, while both its wings (lately completed of poorly built brick and stone masonry) were practically ruined. Among the highest of the older and working buildings are Roble Hall, the women's dormitory, and Encina Hall, the men's dormitory. The former is of reinforced concrete and the latter of well-built brick and stone construction. Neither was damaged beyond the loss from each of two heavy chimneys, which broke off above the roof and went down through the floors where they struck, doing local harm only.

The only example of steel construction is the dome of the new library building, which is supported directly from the ground by steel columns. This dome, with its stone facing, is uninjured—while the building surrounding it is a mass of ruins, its failure being perhaps aided by the vibrations of the dome-tower.

The damage at Stanford is of special interest, as it is from the earthquake alone and not complicated by damage from fire, as in San Francisco. So far as I can see, the earthquake damage in San Francisco was relatively less than at Stanford. I live at Palo Alto and had an office in San Francisco. I reached San Francisco within seven hours after the earthquake, before the fire had gained much headway, and saw many brick buildings then uninjured or but slightly injured, which I now find flat to the ground from the fire. I think all steel office buildings of even passable design and construction were absolutely uninjured by the earthquake. Most of them, except in appearance, seem to have been but little injured even by the fire. Granite columns and facing are of course generally ruined. In my own office, on the tenth floor of the Mutual Bank Building, not even the many books on the top of my roll-top desk were thrown to the floor, the only thing thrown down being a single copy of Engineering News. Later, however, everything in the office was burned and many valuable and unreplaceable company and private records were destroyed.

Two of the three mains of the Spring Valley Water Co. were badly broken by the shock, as were also some parts of the distributing system. It was due to this

FIG. 6. FRONT OF MEMORIAL CHURCH, STANFORD UNIVERSITY, SHOWING DESTRUCTION OF GABLE AND WOODEN SPIRE. PORTION OF TOWER STANDING SUPPORTED FROM GROUND BY STEEL. TRUSSES HAVE HELD SIDE WALLS. HOLE IN BACK OF ROOF CAUSED BY FALL OF TOWER.

FIG. 7. WRECK OF CONCRETE BLOCK STORE AND APARTMENT HOUSE IN PALO ALTO, ONE MILE FROM STANFORD UNIVERSITY. THE WORST WRECK IN TOWN.

cause that the fire was so hard to subdue. The failures of water pipes seem to have occurred principally and perhaps entirely on soft and marshy or filled ground. It is not yet known that any injuries occurred to dams.

Although there has been much discomfort, there has been little suffering in San Francisco since the shock and the fire. Food has been plentiful, good order has been kept, and the people are good-humored and hopeful, and are already beginning to build temporary sheds and resume business. A general feeling of confidence prevails and expressions are heard that earthquakes here are no worse than in Charleston—and are no more to be dreaded than sea-floods at Galveston, cyclones at St. Louis and elsewhere, river-floods at Kansas City and down the Ohio and Mississippi, and fires at Baltimore, Boston and Chicago. California is still believed to have more advantages and attractions than the rest of the country.

Yesterday a meeting was held in Oakland of the San Francisco Association of Members of the American Society of Civil Engineers (of which I am president this year) and some other engineers, with a view to arranging for a professional investigation of the effects of earthquake and fire on the various classes of building construction, also on the water system, sewer system, etc.—and to give any desired engineering aid to the Mayor of San Francisco. On the same day a meeting was held in San Francisco by the Technical Society of the Pacific Coast to proffer engineering aid to the city. Later in the day the two associations combined for this purpose and (through Capt. W. W. Harts as Past-President and myself as President of the former association, and Otto von Geldern as Secretary of the latter) proffered their assistance to the Mayor in person. We are to meet him again on Monday, April 30 for consultation.

From the present feeling in San Francisco, the fire will probably result in the city immediately building a new municipal water-supply system from the Sierras.

Very truly yours,

Edwin Duryea, Jr., C. E., M. Am. Soc. C. E.

308 Lincoln Ave., Palo Alto, Cal., April 29, 1906.

A 15,000-KW. STEAM POWER ELECTRIC STATION to supply current to the entire street railway system of Los Angeles and surrounding towns is to be built for the Pacific Light & Power Co., of Los Angeles, by Chas. C. Moore & Co., Engineers, of San Francisco. The plant will be located at Redondo, on the ocean, where condensing water is available. The generating units consist of three McIntosh & Seymour combined double horizontal and vertical compound condensing engines, grid iron valve type, each direct connected to one 5,000-KW. fly-wheel type General Electric 50-cycle, 18,000-volt alternator. Engines will operate under 175 lbs. pressure, 100° F. superheat at throttle; 27½-in. vacuum. Each engine has two horizontal high-pressure cylinders and two vertical low-pressure cylinders; each engine has two sets of condensing apparatus, one for each low-pressure cylinder so that in case of breakdown of either side of any main engine, the other side may be operated under an overload. Wheeler Admiralty surface condensers are to be used and connected to each condenser there will be a motor-driven Wheeler centrifugal circulating pump, also one Edwards triplex vertical single-acting suction valveless air pump, motor-driven. The air pump and circulating pump motors are supplied with power from an auxiliary generator or may be operated from the main generator. Each main generator has its independent engine-driven exciter. Steam is supplied by means of eighteen 600-HP. Babcock & Wilcox water-tube boilers of forged steel construction, each boiler having integral superheater to give 125° superheat at the boiler nozzle when operating between 190 and 200-lb. gage pressure. Each boiler is equipped with a Peabody patent fuel oil furnace and suitable oil burners. Weber reinforced concrete chimneys will be used. All high pressure steam piping will be specially designed, having rolled steel flanges and lap joints, being one of the recent improvements of the Van Stone joint. Chapman gate valves will be used throughout, specially constructed for use with superheated steam. Electrically controlled valves will be used at critical points. This plant is the largest power plant ever contracted for as a whole on the Pacific Coast and one of the largest so placed in the United States. The contractors are furnishing everything except the power plant building. Heretofore the large steam plants on the Pacific Coast have been used in connection with water power transmission purposes, merely for purposes of reserve. In this instance it is the intention of the owners to operate the plant continuously. The plant is situated near the oil wells and oil will be secured at an exceedingly low rate. The economy of the plant is such that power may be produced and sold in competition with water power transmitting companies. One of the novel features of this contract is the provision for the contractors to operate the plant for a period long enough to insure all parts being in proper working order, and then to submit the plant to a 90-day test under actual working conditions, to determine the compliance with the guaranteed economy of the complete plant, the object being to determine the KW.-hours output of the plant switchboard per barrel of oil burned under the boilers. During this test the entire operation of the plant will be under control of the contractors and sufficient data will be obtained to determine individual performance of the various apparatus. The object of this test is not only to determine the amount of bonus or forfeit due, depending upon the economy of plant, but also to establish a record for the economy of the station which the company's regular operators are subsequently expected to maintain. The contractors will train the company's operators as to the proper manner of operation of plant and considerable interest will be felt in watching the outcome of these tests.

FIG. 8. COURT HOUSE AT REDWOOD CITY, SIX MILES FROM STANFORD UNIVERSITY. CENTRAL DOME SUPPORTED BY STEEL.

Fig. 9. Roble Hall; Girls' Dormitory, Damage Done by Falling Stone Chimney.

Fig. 10. The Museum Building. On the Right: Original Building of Monolithic Concrete; No Steel in Walls. On the Left: Recently Built Rear Wing of Brick, Stuccoed.

FIGS. 9 AND 10. REINFORCED CONCRETE BUILDINGS AT STANFORD UNIVERSITY.

STATEMENT OF HON. WILLIAM H. TAFT, SECRETARY OF WAR, BEFORE THE COMMITTEE ON INTER-OCEANIC CANALS OF THE UNITED STATES SENATE.

A very full statement of the position of the Government with reference to the Panama Canal work, past and present, was made by Secretary Taft before the Senate Canal Committee on April 18. The entire statement, with appended exhibits, occupies nearly 200 printed pages. We have presented below such portions of this statement as are of most direct interest to our readers.

TYPE OF CANAL AND NECESSITY FOR PROMPT DECISION.

I shall not attempt to discuss at all the engineering and technical questions with reference to the type of the canal. I have expressed my opinion in a letter to the President in favor of a lock canal and strongly adhere to it. This committee has had before it able engineers on both sides of the question, and has had full explanations made to it thereon.

With respect to the type of the canal I can only urge with great deference that it is of the highest importance that the question be decided with as much promptness as the subject will permit. The present law—the Spooner Act, so called—certainly intended to provide for the construction of a lock canal. The extent of the financial provision made in the act, when compared with the recommendations of the first Walker Commission, leave no doubt that the intention of Congress was to appropriate money for a canal at a 90-ft. level, with the necessary locks. If Congress decides to reverse this policy and votes in favor of a sea-level canal, then the President is anxious to know it as soon as possible and to begin the work at once.

If Congress decides in favor of a lock canal, or if it chooses not to make any decision at all and is willing to leave the situation as it is upon the law as it is, the President will not hesitate to adopt the plan recommended by the minority, with some possible modifications, and proceed to the speedy construction of the great waterway at an 85-ft. level. I am advised from the Isthmus that Mr. Stevens's work has so far progressed that he will soon be in a position where he must delay all work, or substantially all, until the decision is reached. I have been advised by Mr. Tawney that the time is near at hand when we must be ready with our estimates for the money needed in the construction of the canal for the year ending June 30, 1907. They must be included in the Sundry Civil bill. Mr. Shonts and Mr. Stevens think that the character of the estimates will materially differ as the type of canal fixed upon is lock or sea-level.

I am quite aware of the gravity of the question and of the serious character of a mistake, if mistake it be, in the recommendation of the minority of the consulting board as to the Gatun dam, and while I do not share, I sympathize with the anxiety which must affect any member of this committee if he has real doubt in regard to the stability of the structure which is the distinguishing and indispensable feature of that plan. But however great the responsibility, it must be met, and I submit with great respect that it must be promptly met, in order that there shall be no unnecessary delay in pushing the work.

THE GOVERNMENT OF THE ZONE.

Under the painstaking and efficient administration of General Davis, together with the very satisfactory laws which were enacted by the Walker Commission, with the assistance and on the recommendation of their general counsel, Judge Magoon, the government of the Zone has been in every way satisfactory. Although the population has grown from two or three thousand people to 30,000, the public order maintained has been excellent, taxes have been collected honestly and honestly expended, schools have been established and are being established as rapidly as conditions permit.

The judicial system consists of a supreme court of three judges and three courts of first instance in the three judicial districts into which the Zone is divided. Each member of the supreme court sits as a judge in a court of first instance, and appeals are taken from his decrees to the supreme court in bank. General Davis was opposed to the appointment of more than one judge, on the ground that the business to be done was not enough to justify the paying of three judges. I concur with him in the view that the business now is not sufficient to occupy the three judges as they ought to be occupied, but it seems necessary to have an appellate tribunal and not to submit the important civil and criminal cases which arise to the decision of one judge, especially when in the courts of first instance there can be no intervention of a jury.

Objection has been made that under this system a citizen of the United States charged with crime in the Zone would be tried by a court sitting under the authority of the United States for his life or liberty and convicted without a jury. I submit that the power to do this has been upheld by the supreme court in the Philippines in a case of a citizen of the United States there convicted of a felony by the sentence of the court sitting without a jury. The Canal Zone is certainly no more a part of the United States proper than are the Philippines. It is impossible to distinguish the two cases. It would be utterly impracticable to have a jury trial in the Canal Zone. The people are not used to such a method of trial, and the establishment of the system would make it a farce. There would be few, if any, Americans resident in the Zone to make up a jury, except Government employees, and the natives are entirely unfitted to fill a panel. An American citizen who goes to the Zone must know that if he is charged with an offense he can not have a jury trial.

THE HAY-VARILLA TREATY AND THE POLITICAL RELATIONS BETWEEN THE UNITED STATES AND THE REPUBLIC OF PANAMA.

It is of the greatest advantage to the United States Government in the pursuit of its object on the Isthmus to have the good will and cooperation of the people and Government of Panama. By the logic of the situation we find ourselves and our work in the midst of these people, and it would certainly much increase the great burdens we have at all events, if we have to encounter the hostility of the people of the Isthmus, and the passive resistance, or lack of sympathy, of the Government.

I do not mean for a moment to indicate that the United States cannot take care of itself and suppress by force all obstruction and interferences with its work, but I think it must be conceded that it is greatly better that we live on the most amicable terms with the people of the Isthmus, provided we do not yield to them any rights necessary to us in carrying out our great enterprise.

The people of the Isthmus are vitally interested in the question of how far they may be permitted to trade with the people whom we introduce into the Zone for the purpose of building the canal. They are vitally interested in the rates which we charge upon the Panama Railroad Company and the accommodation which we furnish. They are vitally interested in the order which we preserve in the Zone. They are not so vitally interested in the precautions which we take against yellow fever, for the reason that they are generally immune from that disease; and whether they are vitally interested in sanitary measures taken against other diseases or not, most of the people are quite lacking in sympathy with rigid rules of sanitation which it is absolutely necessary for the Government of the United States to maintain and enforce, not only in the Zone itself, but in the contiguous territory, and especially in Colon and Panama. It is of importance, therefore, that we should obtain from the Panamanian Government not only the right to prescribe health ordinances which must be enforced in Panama and Colon, and other important towns which may be infected, but also that we should be given an opportunity to supervise the enforcement of these ordinances, because in Spanish-speaking countries it is not the form of the law or its declarations which are defective, but it is its administration. We have secured, by the good will of the Panamanian Government, an opportunity to take over from the beginning the enforcement of the health regulations in every town from which it is likely that danger or disease may come, though the treaty granted only the right to enforce health regulations after the Panamanians had failed.

THE OLD COMMISSION, ITS WORK AND THE REASONS FOR ITS RETIREMENT; THE REORGANIZATION; THE NEW COMMISSION AND ITS WORK.

The Commission which was appointed on the 3d of March, 1904, with Admiral Walker at its head, did a great deal of very hard work. It was composed of able and honest men, and in certain directions it secured admirable results. Messrs. Burr, Parsons, Grunsky and Harrod were excellent engineers, and were well adapted to direct the engineering surveys which were projected and begun before a chief engineer was appointed. General Davis, although not by profession an engineer, is nevertheless much better qualified to speak on engineering subjects than most engineers.

General Davis was an admirable man for the organization of the government of the Zone—painstaking, hard-working, clear-headed, economical, courageous and loyal. He was generally absent from the deliberations of the Commission, which usually met at Washington, and he exercised no authority on the Isthmus other than as governor and supervisor of the sanitation measures. He is not, therefore, to be held responsible for such shortcomings of the Commission as may appear.

Admiral Walker had had a great deal of experience in the investigation of both the Nicaraguan and the Panama canals, knew the Isthmus well, and had been an able naval officer. In the selection of the chief engineer, and in the organization of the government of the Zone and the preliminary engineering work, in the organization of the sanitary force, the selection of the chief sanitary officer, in the enactment of the laws for the Zone, the Commission showed itself well adapted to the work which lay before it.

The old Commission organized the sanitary department under Colonel Gorgas, and it is entitled to credit for the success which has attended Colonel Gorgas's efforts, although of course Colonel Gorgas himself is the chief agent in having brought this about. I have been at times inclined to doubt whether the Colonel's plans were best adapted to the speedy sanitation of the Isthmus, and whether he had the executive ability which would lead to satisfactory results; but I am entirely willing to admit that he has vindicated his theories and has carried them to a logical conclusion and has wrought a wonderful change in the health conditions on the Isthmus.

The Commission also began under Mr. Wallace the work of reconstructing the old French houses in which it is intended that the employees and laborers shall live and had reconstructed about 350 out of 2,100 when Mr. Wallace left. They constructed a hotel at Corizal and a hotel at Culebra, and they projected and almost completed before they were retired the water supply for the city of Panama, and for many of the other towns in the Zone. They attempted to secure the needed employees to make the working force on the Isthmus. The application of the civil service law in a modified form and their reliance on the Civil Service Commission to furnish employees did not result fortunately. The truth is that neither the Washington bureau of the Commission nor the Civil Service Commission was able to furnish the skilled workmen and "outside" employees that were required. The Civil Service Commission did not have eligibles of the kind needed or machinery to secure them. This country was prosperous, most people who would have been useful on the Isthmus had employment, and it was difficult to secure the kind of men who were wanted. Mr. Wallace complained greatly of the incompetency of the men who were sent to him, and I am bound to say that his complaints were well founded. I do not think that in this respect the Commission met the situation. The application of the civil service law could have been modified to meet the exigencies, as it has been since. It would have been better if they had sent out competent, professional employers of labor to secure the proper men, as the new Commission has since done. As the work expanded and the demand for men grew greater, the defect of its organization in this respect became more apparent.

The work of excavation which was done by Mr. Wallace under the old Commission at Culebra was carried on largely for the purpose of experiment. I do not feel competent to pass judgment on the wisdom of what was done there. The use of the Belgian engines and the French tracks and the small cars and the old French dumps, which were not well placed, and the lack of the element of the long haul, which will probably enter largely into the cost of most of the excavation, created such a difference between the experimental and the actual conditions to be met that I am inclined to think that the data obtained are not very valuable and that the time and attention spent might better have been put on the construction of houses and the sanitary construction work of which there was so much needed. But I venture this opinion with great hesitation and with deference to the judgment of Mr. Wallace and the professional engineers of the old Commission. Certainly the excavation of 700,000 cu. yds. is an excavation that will not have to be done again.

I am sorry to have been misled into the incorrect statement of Mr. Stevens's views which Mr. Wallace regards as a slur upon his work. From Mr. Stevens's reports, and from his evidence until the question was definitely put, I had supposed that he intended to say that some of the dumps used by Mr. Wallace would have to be moved, and so some members of the committee understood Mr. Stevens's statement to mean this, but when the direct question was put it appeared that while some of the old French dumps where material was deposited by Mr. Wallace would have to be moved, none of the material which Mr. Wallace placed there would have to be removed. I regret the mistake very much.

The chief defect of the old Commission, if I may say so, became apparent when it essayed the tremendous executive task of perfecting an organization to furnish the equipment, the material, and the supplies required in increasing quantity on the Isthmus as the work expanded, with promptness and dispatch. This was a complaint which Mr. Wallace might most justly make and which he did make. It was one of the chief obstacles in the performance of his task.

I do not mean to say that under any circumstances and under any management the opening of the canal project and the ordering of equipment, supplies and construction material at such a long distance would not have been attended with exasperating delays, but it is quite apparent that the methods of the Commission for this purpose were not businesslike, expeditious or systematic.

The purchasing department was conducted by Mr. Redfern, who was a secretary or clerk in the office with but little previous experience as a purchasing agent. While he was a hard and faithful worker and did all he could, he was swamped with the requisitions which came to him; so that on February 1, 1905, when Major Gallagher took hold he found a great number of requisitions in the office of the Commission that had not even been opened.

THE RATE OF FILLING THE SALTON SINK BASIN BY THE DIVERSION OF THE COLORADO RIVER.

By an Occasional Contributor.

The problems presented by the diversion of a large river in an alluvial or delta plain are well illustrated in the difficulties now existing on the Lower Colorado.

This river is heavily laden with fine sediment and has, during the past centuries, built up an enormous delta of this material. Like other alluvial rivers of similar nature, its channel was a groove on the top of a very broad ridge. It differs from other alluvial streams, however, in possessing, as a possible outlet, a large basin which is much below sea level and which greatly complicates the problem of its control.

When an attempt was made to divert the waters into a canal in an alluvial bank without any dam [see Engineering News, Feb. 22 and March 15, 1906] a great difficulty was presented in the fact that such water as was diverted into the canal was checked in its velocity and, consequently, tended to deposit its great load of sediment, which rapidly filled the canal. Constant effort was required to keep this open. This tendency was combatted by building new headings for the canal at points where a greater declivity could be obtained and by providing a much larger and deeper canal prism. The introduction of gates into the canal also had a tendency to check the velocity of the water and to produce eddies, and consequent deposition of mud around the gates. These were quickly silted up and rendered useless. It was found much easier to maintain a channel without any gates.

Finally, a very large and deep prism without gates was constructed at a point on Mexican soil where a good fall could be given the canal, and it was found that at ordinary stages the scouring effect was sufficient to keep the canal open, and the question of sedimentation was thus triumphantly solved.

As soon, however, as a rise in the river occurred, a new difficulty was presented: the enormous volume of water and the high grade produced a scouring effect, which, in turn, increased the volume of water and aggravated the conditions, resulting in the diversion of the entire Colorado River to the Salton Desert, of which so much has recently been published.

It is, in fact, impossible under the circumstances to provide a permanent and safe diversion from this river in an alluvial bank, for at low water there is a tendency to sedimentation and, at high water, to erosion, and no combination of conditions can be safe without a heading founded upon rock.

At present the California Development Co. is engaged upon its seventh attempt to control the river and force it to take its old channel. The outcome of this attempt cannot be predicted, but it is planned, this time, to found substantial head gates upon solid rock.

Much speculation has occurred regarding the probable result of continued failure to control the river. The accompanying map shows that from the point of diversion, near Yuma, to the margin of Salton Sea, the distance is about the same as that to the Gulf of California, while the fall is 253 ft. greater, or nearly three times as much as the fall through the old channel to the sea. Under such circumstances, of course, the river is cutting rapidly, and the bottom of the river at Yuma is 2 or 3 ft. lower than it was before the diversion. This progressive deepening renders the rectification of the river more and more difficult as time passes on, and it becomes a problem of interest and importance to predict what will happen if control of the river be not successfully accomplished.

A survey has been recently made of the Salton Basin by Mr. W. Carvel Hall, a topographer of the U. S. Geological Survey, and the results are shown on the map. Fifty-foot contours were carefully located for the area below sea level and the old beach line, 30 ft. above sea level, was also located. Mr. Hall has also made an estimate of the time that will be required to fill the basin to various levels under certain assumptions, which are as nearly correct as existing data permit. These are, that the main flow of the river will be what it has averaged (at Yuma, Ariz.) for the past eleven years, namely, 8,000,000 acre-foot per year, and that the mean annual evaporation, less rainfall, will be 7 ft. or 84 ins.

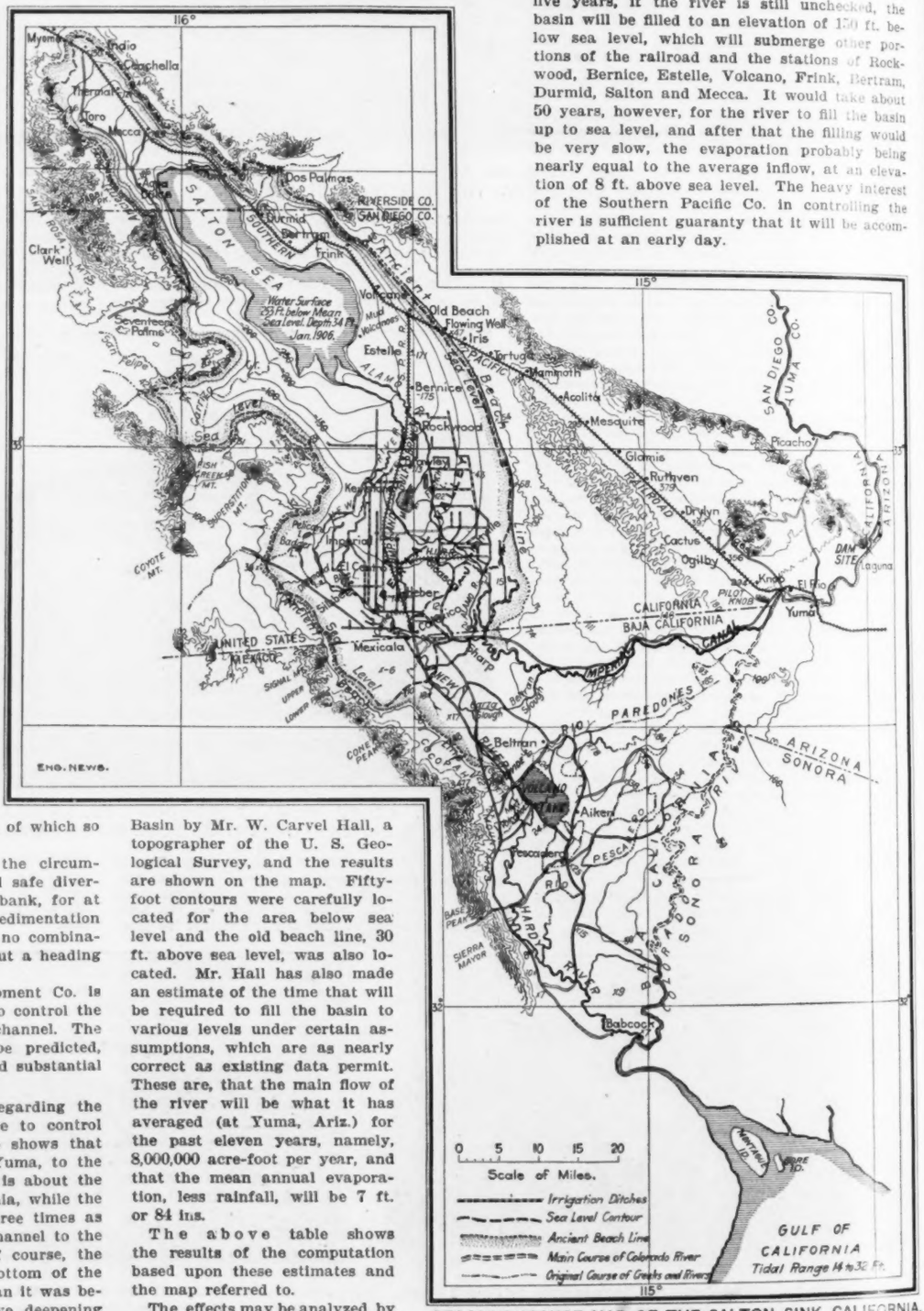
ESTIMATE OF TIME AND QUANTITIES REQUIRED TO FILL SALTON SINK TO VARIOUS LEVELS.

Present water surface*	−253	−200	−150	−100	−50	Sea lev.	+30
Area, sq. mi.	247	447	647	916	1,146	1,753	1,947
Area, acres	158,100	286,100	414,100	586,200	733,400	1,121,900	1,246,100
Water required† to fill section	.....	11,771	17,505	25,007	32,990	46,382	55,529
Water required† to raise Salton level	.....	11,771	29,276	54,284	87,274	133,656	189,176
Evaporation† per yr. using mean area of sec.	.....	1,555	2,451	3,501	4,619	6,494	8,288
Amount of total river flow to equal evaporation, per cent.	.....	19	31	44	59	81	105
Net water† remaining to fill section	.....	6,500	5,500	4,500	3,300	1,600	0.0
Time required to fill section, years	.....	1.8	3.2	5.5	10.0	29.0	.....
Total time required to raise surface, years	.....	1.8	5.0	10.5	20.5	49.5	.....

*Elev. in ft. above mean sea level.
†Thousands of acre-feet.
The evaporation would about balance the inflow when water surface reaches an elevation of + 8 ft.

The above table shows the results of the computation based upon these estimates and the map referred to.

The effects may be analyzed by consulting the map, which indicates that in less than two years, unless checked, the basin will be filled to an elevation 200 ft. below the sea level. This will submerge considerable portions of the Southern Pacific Railroad along its latest location. In five years, if the river is still unchecked, the basin will be filled to an elevation of 150 ft. below sea level, which will submerge other portions of the railroad and the stations of Rockwood, Bernice, Estelle, Volcano, Frink, Bertram, Durmid, Salton and Mecca. It would take about 50 years, however, for the river to fill the basin up to sea level, and after that the filling would be very slow, the evaporation probably being nearly equal to the average inflow, at an elevation of 8 ft. above sea level. The heavy interest of the Southern Pacific Co. in controlling the river is sufficient guaranty that it will be accomplished at an early day.



RECONNAISSANCE MAP OF THE SALTON SINK, CALIFORNIA.
(Redrawn from Advance Sheet, U. S. Geological Survey; W. Carvel Hall, Topographer. Elevations and Topography in Mexico are approximate.)

created a panic and that he supposed a great many men would go back on that week's steamer to the United States. He said:

I think I have never known of an instance where the strong directing hand of a man in power was more necessary than it is here now. Mr. Dauchy does the very best he can, and is patient and painstaking, but he is not regarded as the "head" in the real sense.

In a telegram to me of May 4 General Davis said: "At no time since I have been here has there been so great necessity for presence of strong directing head of canal work, a head recognized by the public and by all as commanding the confidence of the President and Secretary of War. The absence of such a man at this time, in my opinion, is exceedingly detrimental to public interest."

This description of conditions by General Davis and Mr. Dauchy are confirmed by Mr. Wallace in his letter of June 8, in which he says:

Upon my arrival on the Isthmus it was needless to say that the entire organization was found in a state of more or less demoralization. At the same time, the spirit of disloyalty mentioned by Mr. Barrett did not exist. The feeling was more one of depression and discouragement.

* * *

The dissatisfaction among the men, however, that gave the most anxiety was of the silent, unexpressed nature, which is existing among our loyal and better class of employees. In time this would have resulted in their gradually leaving the Isthmus as they were offered positions in the States, or in taking their leaves of absence in the normal way and not returning, provided they could find any other means of earning their living. Above all was the disadvantage to the work where men were compelled to remain here in order to earn a living, the silent feeling of discouragement.

While, of course, the President and I were concerned over the situation, we were very hopeful that with the reorganized Commission and the new courage which Mr. Wallace had evidently taken by his trip, and the promotion given him, matters would gradually be straightened out. It was his presence on the Isthmus and his strong hand in coordinating the parts of the machine which under Mr. Dauchy had drifted apart that we were counting on.

Under these circumstances I received with surprise and anxiety the following telegram from Mr. Wallace, dated Panama, June 5, 1905, only a fortnight after his return to the Isthmus:

Secretary of War, Washington.

Important complicated business matters which can not be arranged by correspondence and which may affect my relations as chief engineer of Commission necessitates immediate return to the United States to confer with you and others. An order from you to return for official consultation will prevent apprehension on the part of employees. Suggest Shonts remain until my arrival. Please answer. Wallace.

My surprise and feeling of uneasiness were not relieved by receiving about the 15th or 16th of June the letter from Wallace, dated June 8, 1905, already among the appended exhibits, and containing the following:

* * *

Since my return I have been most vigorously employed in arranging for the reorganization of the work and in stiffening up the weak points.

In the meantime cables and letters have been received from the States in regard to matters which vitally concern my personal interests, which could not be brought to a consummation before leaving the States.

There are also several matters which it is desirable to discuss with you before your departure for the Philippines, which I do not think it wise to hold until your return, and which can not satisfactorily be handled either by cable or by letter.

While they might be considered largely of a personal nature, any action taken for my personal interest would affect, to a greater or less extent, the work here.

* * *

My intention was to make a hurried trip to the States, in order to return here in time to be present at the meeting of the Commission on the 2d of July.

However, it is possible to make such progress in my reorganization work that I believe that I can finish everything up and sail for the States on the steamer "Finance," which will leave here Monday, June 12; and as I have been continuously at work for the Commission without any vacation (having taken practically none when in the States), I respectfully request that I be granted at least six weeks' leave of absence, dating from the completion of the conference with yourself and the chairman of the Commission, or after I have finished such business as I may be called upon to attend to in Washington or New York for the Commission or the Panama Railroad.

I know of no time during the next year when the work will be in better condition to permit of my absence. It is thoroughly organized, everything possible that can be foreseen provided for, and a feeling of loyalty and enthusiasm now permeates the entire personnel.

On landing in New York, on the 19th or 20th of June, I would like to spend one or two days there on matters connected with the Panama Railroad before I proceed to Washington, when I hope you will be able to give me a personal interview.

This letter certainly furnished but little light on the real state of Mr. Wallace's intentions, except that he wished to be absent from the Isthmus on vacation for July and August, at the very time of all others when he ought to have been there. He had then been just twelve months and a half in the employ of the Commission, of which he had spent nine months on the Isthmus and three and a half in the United States or on the ocean, and part of this three months and a half he had devoted to matters not governmental. In a day or two I received light in the following letters from Governor Magoon:

[Personal and confidential.]

Isthmian Canal Zone,
Executive Office, June 11.

My Dear Mr. Secretary: Mr. Wallace has had two conversations with me of such character that I feel obliged to communicate the substance to you. He says he has received an offer of employment in the States that affords him more pay and better opportunities than his present position. He is going to the States (as you have been advised by cable) to resign as chief engineer, to take effect September 1, but is willing to remain as a member of the Commission. He further wishes to take a vacation until September 1, and prepare his annual report at his home in Chicago, and not return to the Isthmus. "Here ended the first lesson."

I was anxious, of course, to probe the matter further and ascertain if there were anything back of it, and therefore sought another interview the next day, told him of my anxiety as to the situation, and asked if there were anything in his relations with me, personal or official or our relative standing, etc., that was objectionable. He said, "No. The trouble lies in another direction;" and proceeded to object to the requirement that he should remain on the Isthmus except when given permission to leave; to receiving less salary than Shonts; and to being placed in a position subordinate to the chairman, "who was getting the credit of bossing the job."

It was plain, by this time, that there was something deeper yet, and so I asked him if any arrangement could be made that would satisfy him and induce him to remain and he said "there might be, but I don't know." He went on to say that the only thing that would induce him to remain was to make him chairman, combine the two departments of which he and Shonts are the heads, and give him full power over all the work, complete and unrestricted; fix his salary at between $50,000 and $60,000, he to come to the Isthmus when he saw fit and depart as his discretion determines. The plan he has in mind is, that he is to be so completely vested with all authority that no one can doubt or question that the entire credit of the enterprise in all branches belongs to him. He said nothing as to his plan being the more efficient, but confined himself to statements that such was what he wanted.

I asked him if he intended to talk to you as frankly and candidly as he did to me. He said he wrote you a letter last March, in which he told you what he wanted done, but his wishes were not carried out; that he made it a rule in dealing with his superiors to let them know what he wanted and "leave it to them." He made a further statement, to which I attached grave significance—that he left the Illinois Central twice without telling them, directly, what he wanted, and was sent for and given three times as much as would have induced him to remain at the time he left.

Evidently he considers himself essential to this enterprise, and, for the immediate present, he is. He has never secured an assistant engineer competent to take his place or keep the work going at a decent pace for sufficient time to enable a new chief engineer to master the situation. His department is not organized, i. e., the machine is not built and therefore can not run itself. I have urged him several times since we came here to appoint some big men in his department and put them at work on his organization; but he said it was difficult for him to secure the men he wanted. The data he has collected is scattered through his files and he said he could incorporate enough of it in his report to enable his successor to understand and utilize the substance of it all. I doubt it.

Speaking of his desire to be the head of the enterprise, he told me that he figured from the first that Admiral Walker would not last more than two years and he had intended to have things in such shape by that time that he would be made chairman; but the old Commission went to pieces too quickly for him. When to the present development is added numerous incidents occurring during the past two months, incidents that appeared to be trivial at the time but now appear important indices, I cannot escape the conviction that he is trying to "pull off" a carefully contrived coup d'etat. I think he expects to go, but to be recalled in the future. I hope I am doing him a grave injustice, for personally I like him and our relations have been very pleasant. I can readily understand that from his point of view the action and motive I attribute to him is entirely justifiable. In railroad circles, as on the stock exchange, it is entirely justifiable and even commendable to "squeeze" friend or foe when you have the chance and can profit by it.

That something like this is in his mind is indicated by his telling me when I urged him to have a full and free talk with you that he had thought of going to Shonts and "putting it to him straight." I am very sorry this complication has arisen on the eve of your departure for the Philippines. I had hoped to advise you before you started that everything here was in smooth sailing. It is of course unnecessary for me to say that I have urged upon him every argument I could muster to induce him to maintain the status quo, at least until your return. I have written you thus fully that you may have a few days to turn the matter in your mind before the matter presses for determination.

I have no objection to this letter being read by the President and Mr. Cromwell, but request that no one else be permitted to know of its existence.

Very truly yours, Charles E. Magoon.

Isthmian Canal Zone,
Executive Office, June 13, 1905.

My Dear Mr. Secretary: I have had another talk with Wallace and am inclined to think I judged him too harshly in concluding that he was attempting to "squeeze" you.

He seems to be fully prepared to quit, but willing to remain upon terms that seem to him justifiable as compensation for the sacrifice he feels he would make in continuing in the public service. There is no difference in its effect on the public service, but there may be considerable difference between the two mental attitudes. You will, however, have opportunity to judge that matter for yourself.

Yours sincerely, Chas. E. Magoon.

I took these two letters to the President at once. I told him that I thought there must be some mistake. I could not believe that Mr. Wallace, under the circumstances that existed on the Isthmus, with the loyalty and gratitude for the new arrangement he had gone out of his way to express, would thus desert us without notice or time to select a successor. Mr. Wallace's own letter, while it had some ambiguous phrases in it, certainly did not give the impression that he was leaving the Isthmus for the last time with no intention of returning as chief engineer. Yet, of course, Judge Magoon had no motive for misrepresenting what Mr. Wallace had said to him; he had detailed the conversation in Mr. Wallace's words immediately after the conversations.

Assuming the situation to be, however, as Judge Magoon stated it, I said to the President that the departure of Mr. Wallace from the Isthmus would be the most demoralizing thing that could happen in a state of demoralization already existing, that there was a crisis on the Isthmus, and that if Wallace had purposely selected the time when his leaving and desertion would be most injurious to the public interest he could not have succeeded better. For that reason I requested of the President the authority, if Wallace's statement to me was in accord with Magoon's report, that I might dismiss Wallace at once and demand his resignation both as Commissioner and as vice-president and general manager of the railway. I expressed the opinion to the President that it was of the highest importance that we should stop the desertions which were going on upon the Isthmus, and that we should mark our disapproval of the disloyalty to the job involved in running away from the Isthmus under the circumstances and conditions that prevailed there, especially in him upon whom rested the greatest responsibility. I need hardly say that the President fully concurred in my views and gave the authority which I requested, with the emphasis which such a condition was likely to evoke from him.

In spite of the very conclusive evidence as to Mr. Wallace's state of mind and intentions found in Judge Magoon's letters, I was still not satisfied, and therefore requested Mr. Cromwell, when he returned to New York, to use the Western Union cipher and inquire of Judge Magoon by cable whether he confirmed his letters.

As I was exceedingly busy making ready for my trip to the Philippines, and had an engagement to deliver an address before the Yale Law School on Monday, the 26th, and to attend the Harvard commencement on Wednesday, the 28th of June, at Cambridge, where I was to meet President Roosevelt, it was economy of time for me to have the interview with Mr. Wallace in New York City. I went to New York Saturday afternoon, and met Mr. Cromwell at the Manhattan, when he handed me the following telegram which he had received from Governor Magoon:

[Confidential, Western Union Code.]

Panama, June 22, 1905.

Cromwell, New York:

As result of all interviews, I believe he retires in good faith prompted by attractiveness of new position, salary, residence in New York, business connection with financial magnates, opportunity to demonstrate administrative ability instead of working at construction exclusively; also fear of yellow fever on the part of himself and wife. He desires to become an engineer member of Commission, basing it on desire to assist and prevent embarrassment if any question should arise direct, he said. Cannot say whether he would remain in any other capacity nor on what terms until after (he has) interview with New York parties, but (he) will not continue as construction engineer merely. (His) wife told intimate friends here they would not return. They have taken or sold all of their belongings.

My impression, based on interviews and (one word illegible), is that personal advantage and (word illegible) overcome public consideration involved; that he is not attempting a squeeze, but honestly thinks he is entitled to supreme place and power. (He is) unwilling to remain without it and not particularly anxious to remain without (with?) it provided new position is what he considers it. He asked me to telegraph Secretary (advising) his retention on Commission as one of four engineer members. I will comply, believing retention advisable. Magoon.

Mr. Schwerin came in to see me in regard to the Pacific Mail contract with the Panama Railroad. After Mr. Schwerin left, Mr. Wallace and his son came in. After some little conversation young Mr. Wallace withdrew. I recollect telling Mr. Cromwell in Mr. Wallace's hearing that I desired him to stay.

I did this for the reason that I wanted a witness to the interview. I knew it would be of a serious character, and I had asked Mr. Cromwell to make notes of the interview so that I might take those notes to the President and submit to him the condition of things as it was revealed by what Mr. Wallace had to say. After the interview with Mr. Wallace, I had to hurry to catch the train for New Haven. Mr. Shonts, who had come to the hotel after the interview, traveled with me to Bridgeport, in the vicinity of which he was staying for the summer. As the result of the interview with Mr. Wallace, I directed Mr. Shonts to do his best to find another engineer at once.

I met the President at Cambridge and gave him notes of the interview, and said to him that the correspondents of the newspapers were pressing me for the facts in regard to Mr. Wallace's leaving; that many different reasons were being given, and that the facts unexplained could not but have a most detrimental effect upon the discipline and esprit of all our employees on the Isthmus. In view of this, the President was strongly of opinion—and I agreed with him—that the interview ought to be published, for the purpose of discouraging in the future such an act of disloyalty as that of which we both considered Mr. Wallace guilty. Accordingly I returned to Washington and prepared the published statement.

The body of seven Commissioners, with each one an executive, was not well adapted to the growing work. Admiral Walker frequently said to me in the trip which we took to the Isthmus in December, 1904, that some change must be made in the organization of the Commission if the proper results were to be obtained. I think that the admiral felt that if he had the executive power himself he could meet the situation, but that with a clumsy body of seven constantly called upon to exercise executive functions as a unit, rapid and efficient action was most difficult to obtain.

Colonel Hecker resigned November 16, 1904, and it was understood at the time from Colonel Hecker that the chief reason for his withdrawal was his feeling that under the present organization the Commission was not likely to accomplish well the purpose for which it was created and appointed.

Mr. Parsons and Professor Burr visited the Isthmus in February and March, 1905, and on their return Mr. Parsons advised me of his intention to resign from the Commission on the ground that it was not so organized as to make executive work by it successful. He expressed himself in the same way to the President. He sent to me a plan of reorganization which he regarded as one which would work.

General Davis, under date of January 6, 1905, wrote me as follows:

> The newspapers have stated that in the special report which you have recently submitted to the President a recommendation is contained for a reduction of the number of members of the Isthmian Canal Commission. I hope the report is true, for I am satisfied that the present body is far and away too cumbersome and ineffective.

In reorganizing the Commission we attempted to follow the suggestions of Mr. Wallace, Mr. William Barclay Parsons and General Davis.

The order of April 1 specified the duties of the chairman of the Commission, and the other members of the Commission, made the chief engineer a member of the Commission, and the governor of the Zone a member of the Commission, and constituted them an executive committee with power to act. The remaining four were engineers, and were paid a considerably less salary than those which were provided for the chairman of the Commission, the chief engineer, and the governor of the Zone; or, to put it in another way, the salary of each member of the Commission was fixed at $7,500, and the chairman received in addition to that as chairman $22,500, the chief engineer received $17,500 additional, and the governor of the Zone $10,000 additional.

The result of the operations under the old Commission convinced me and convinced the President that it was absolutely essential to have a completely new organization in Washington for the purchase and forwarding of supplies, machinery and construction material, and also for the procurement of the needed employees. In other words, it was essential that this work should be attended to by someone who had large experience in the construction of railroads or other important work, and who understood the methods by which the parts of the organization were assembled and made effective. A number of candidates were selected, and after a careful investigation, the President concluded that Mr. Shonts filled the requirements of the position in a most satisfactory way.

I do not hesitate to say that one great difference between the work of the old Commission and of the new is due to Mr. Shonts's experience and energy in effecting and maintaining an organization for the purpose of selecting employees, making proper contracts for the purchase of needed machinery and material, pushing forward the transportation of such equipment and supplies and for instituting a proper system of accounts and records.

The whole office of the Commission in Washington was reorganized. Mr. Benson, an auditor of long experience in railroads, was made the general auditor of the Commission; Mr. David W. Ross, one of the ablest railroad purchasing agents in the United States, was employed to reorganize the purchasing department, and the selection of employees was placed under Mr. Pepperman, who had large experience in civil service, both in this country and in the Philippines.

The organization has, on the whole, worked very well. When Mr. Stevens succeeded Mr. Wallace he was not made a member of the Commission, so that the executive committee now consists only of Mr. Shonts and Governor Magoon. This would have been inconvenient but for the presence of the four engineer members of the Commission in Washington, where Mr. Shonts has been; so that it was possible to do all necessary business through the Commission instead of an executive committee.

THE PANAMA RAILROAD.

While the Panama Railroad was able to do the commercial business and had in 1902 completed a large dock at La Boca, on the Pacific side, at a cost of $2,200,000, it has been quite apparent that the road with its equipment and one track and the terminal facilities, even with the La Boca dock, is wholly inadequate to the business which must now be done on it as an instrumentality for the construction of the canal. The Canal Commission has therefore made an arrangement to advance about a million dollars out of their funds to the railroad company to make needed improvements, which include a very great enlargement of the terminal facilities and docks and the double tracking of the road. The equipment of the road is not up to date, and new engines and new cars have been required.

One of the questions presented with reference to the railroad company was the policy of continuing the steamship line. General Davis in his report had recommended that the steamships be sold and that the operations of the Government be confined to the running of the railroad. I was very much inclined to this view myself, and I believe that that is the view of Mr. Wallace; but further investigation satisfied me that it would be exceedingly unwise, with an established line, if we could make the line pay expenses, to abandon an instrumentality that would enable us to control the rates of freight from the United States to Panama.

Another question which has been mooted with respect to the railroad is that of rates. The fact in respect to the rates on the railroad is that we have lowered them as much as we feel justified in doing at present, with the present equipment of the railroad and the inability to do the business as economically as we hope to do it. We can not afford to make our charges below what it costs us to run the railroad, and the fixed annual charge of more than $5,000 a mile which we have to pay as a subsidy, of course, increases the rate of freight which we must charge.

Mr. Wallace thinks that we ought to make a flat rate of $2 a ton across the Isthmus for everything. He once suggested this to me, and it was very attractive in its simplicity and resemblance to canal tolls on ship tonnage, but one difficulty is that the cost of conveying the freight is $3.06 a ton, as the traffic manager of the road advises me, which would make a loss to us in running the railroad of $1.06 a ton. Instead of that, our average charge is about $3.69 a ton, which does not make an unreasonable profit. We have reduced the freight rate from New York to Panama on most goods 33⅓% or more. We are not much more than paying expenses with our shipping line. The through rates are divided, 45% to the railroad and 55% to the steamship. Two other steamship lines run from New York to Colon, the Royal Mail Line and the Atlas Line, and a line from New Orleans to Colon, all of which connect with us. From all of these lines the railroad accepts the same pro rata proportion, 45%, and thus makes no discrimination and attempts no monopoly.

Some suggestion has been made that the question of the effect upon the cost of transportation over the eastern and the western seaboard by transcontinental lines plays a part in our rates on the Isthmus. I beg to say that this is altogether contrary to the fact so far as the Commission, the Panama Railroad Company, and the Administration are concerned. The intimation is that we have drawn our executive officers, Mr. Shonts, Mr. Stevens, Mr. Ross and Mr. Benson from railroads, and that some of them have been connected with the transcontinental railroads. We did not consider when they were appointed what roads they had been connected with. What we were anxious to do was to secure the best men, and while doubtless they were loyal to the roads they left while they were in their service, there is not the slightest reason to suspect that any one of them has any bias whatever which would lead him in his official capacity to oppose any traffic policy of the Panama Railroad Company which might affect injuriously in a competitive way transcontinental lines. I am informed—I do not know how correctly—that the rates to San Francisco via the Isthmus are now about 30% less than the transcontinental rates. If we find that we can, without running the railroad and the steamship lines at a loss, reduce these rates, we shall do so.

THE RELATIONS OF WILLIAM NELSON CROMWELL TO THE GOVERNMENT'S CONSTRUCTION OF THE CANAL AND THE ASSISTANCE WHICH HE HAS RENDERED.

Upon coming into relation with Panama Canal matters I found Mr. Cromwell acting as general counsel and director of the Panama Railroad Company. He was also counsel for the Republic of Panama and for its resident minister in Washington. In the discharge of his duties as counsel for the railroad company he brought to the service of the company, and therefore to the Government, an immense fund of valuable information with respect to the history of the railroad and affairs on the Isthmus of Panama. He was a lawyer of great experience and ability, and I considered it my duty to secure the benefit of his services for the United States by continuing him in his position as counsel for the railroad company. As counsel for the Republic of Panama he rendered much service in bringing about both the currency agreement of June 20, 1904, and the modus vivendi of December, 1904. As counsel for the railroad company and at my direct instance he was able to effect a union between all the bankers of any importance on the Isthmus in making the bankers' agreement of April 29, 1905, which worked so well for the benefit of everybody concerned, except possibly the bankers. As counsel for the railroad company he was the chief instrument by which I was able to purchase on behalf of the Government all the shares of the capital stock of the Panama Railroad Company outstanding. I conferred with him in respect to the form of the order of April 1 reorganizing the old commission. His intense interest in the success of the Panama Canal has been evident at every point, and he has rendered most loyal, efficient, and valuable service for the comparatively meager compensation which he receives as general counsel for the railroad company.

The impression sought to be given that he has attempted to interfere in canal matters or to exercise great influence in controlling the policies to be pursued is wholly unfounded. So far as I have asked his assistance, he has sought to find out what the Government policy was and loyally to carry it out. If Mr. Shonts or Mr. Stevens or Judge Magoon were interrogated as to whether Mr. Cromwell had interfered in any way with their work or had of his own motion volunteered to do anything except what has been his legitimate duty as counsel for the railroad company, the answer would be an emphatic negative. I never have had the slightest reason to suspect any other motive on his part than a loyal desire to help along the construction of the canal, and I am glad to express in this public way my gratitude for his valuable and patriotic service.

THE CIRCUMSTANCES LEADING TO THE SEVERANCE OF MR. WALLACE FROM THE CANAL ENTERPRISE.

I met Mr. Wallace for the first time in November, 1904, when I was on the Isthmus. I was quite impressed with his earnestness and interest in the work, his ability, his facility of expression, his power of planning ahead, and the experience that he had had on the great Illinois Central system.

The selection of Mr. Shonts by the President was induced not only by Mr. Shonts's experience and ability as an organizer of constructive enterprises, but also because he was believed to be on friendly terms with Mr. Wallace.

Mr. Wallace came to Washington to assist at the reorganization early in April, 1905. After he had been here a month working with Judge Magoon and Mr. Shonts on the needed changes in the Washington office, and necessary preparations for the Isthmus, reports of a disquieting character as to the conditions on the Isthmus began to come to me. I was anxious that Judge Magoon and Mr. Wallace should then return to the Isthmus. Mr. Wallace, however, requested that he be allowed to take two weeks in Chicago before going back, on personal matters, saying he could unite public business with the main object of his trip. On May 15th or 16th, just before Mr. Wallace sailed, he came to my office with Judge Magoon and others. After a little conversation he asked that the others precede him from the room and he remained for a last word with me alone. He said he was not content to leave without expressing in a personal interview the profound gratitude that he felt to the President and to me for reorganizing the Commission on the lines of the order of April 1. He said he went bact to the Isthmus with happiness in his heart and with confidence that the canal would be built and that he would build it. He asked me to convey this message to the President and to assure the President that he could have every confidence in him. I invited his attention to the disquieting rumors as to the condition of the employees on the Isthmus and asked him to devote his chief attention to the reconstruction of buildings for the occupancy of our employees and to making them comfortable.

Before Mr. Wallace sailed he had received letters from Mr. Dauchy and General Davis, which I attach as Exhibit 18, showing a most demoralized condition on the Isthmus. The rainy season had set in and yellow fever, which it was supposed had been stamped out, showed itself in the last week in April, and six cases of fever—all of them employees at work in the canal building—were reported. Mr. Dauchy described the very unsatisfactory condition on the Isthmus, and especially at Culebra, showing that the conditions were due to the result of lack of preparation, and because material and men were wanting. He wrote that the yellow-fever scare had caused great demoralization in the whole personnel. He said that on account of having no lumber he had not been able to push the work of preparing quarters for men; that at that time they were more crowded than at any time since the work started, and that this crowded condition was causing dissatisfaction. He said that he had not the superintendents or foremen or engineers to enable him properly to instruct the men under him, and that without an organization he could not cement the force into a working organization commensurate with the requirements of the work.

General Davis, in his letter to Mr. Wallace under date of March 3, says that there was no head there to command the necessary confidence and respect, and there was a great deal of bickering and fault-finding and scolding among the employees all along the line; that they were now pitching tents in Culebra for the shelter of the United States employees, and the employees occupying the tents were naturally discontented and found fault; that the death of Johnson and West, one the superintendent of construction and the other the auditor, had

I do not stop to discuss Mr. Wallace's legal right to quit under his contract. That is aside from the real point. Mr. Wallace knew that a crisis was at hand in the business of the Government at the Isthmus and that his desertion at that time might mean disaster. He was under the highest moral obligation not to leave his post until he had given the Government an ample opportunity to replace him. His obligation in this regard was commensurate with his great responsibility and the difficulty of suddenly finding a substitute for him. Mr. Wallace seems to recognize some such obligation. He says in his testimony that it was his undoubted personal right to resign whenever he thought it necessary to do so, provided, of course, that he took abundant care that the work in his charge would suffer no harm by reason of his resignation. His justification for his course is contained in his letter of June 8, already quoted, in which he says.

I know of no time during the next year when the work will be in better condition to permit my absence. It is thoroughly organized, everything possible that can be foreseen provided for, and a feeling of loyalty and enthusiasm now permeates the entire personnel.

It is true that Mr. Wallace raised the wages of all the employees, black and white, on the Isthmus, and this doubtless gave some satisfaction, but in no way stopped the panic or checked the demoralization. That he perfected the organization in the time between the 24th of May, when he reached the Isthmus, and the 16th of June, when he left there, is without foundation.

Mr. Wallace says that Mr. Dauchy was there, and quite as competent as he was, acting as chief engineer, to carry on the work. I need only refer to General Davis' comment on the condition of things when Mr. Dauchy was in charge to refute Mr. Wallace's statement upon this subject. More than this, Mr. Wallace contradicts himself by his conduct in respect to Mr. Dauchy, for he says in his letter of June 8, already an exhibit:

The greatest handicap at this time is the lack of several high-class assistants. All the men here are loyal and perfectly competent in the handling of their several divisions or bureaus as the work now exists, but, in view of the large amount of organization and expansive work, several high-salaried men are needed who should be personally selected by the chief engineer. Since my original appointment as chief engineer this matter has been given constant thought, and a great many men considered for the more important positions that have not yet been filled, particularly that of assistant chief engineer.

Refusal after refusal has been met with, although as high as $15,000 per annum has been offered in a tentative way. This position is a most difficult one to fill, probably much more so than it would be to select a successor to the chief engineer, as his assistant must necessarily have ability fully equal to that of his superior, and be perfectly competent to step into his place should ill health, inclination, or any other reason cause the chief engineer to leave the service. It is absolutely necessary that a man of this character should be secured without further delay, and that he be personally selected by and be a man in whom the chief engineer has perfect confidence. It will also be necessary to employ other high-class men in the immediate future. It was the intention of the chief engineer to secure these men on his recent return to the United States after personal conferences and full investigation of their records, but the important matters connected with the reorganization of the Commission and the Panama Railroad have prevented; and on account of the demoralization which had occurred during my absence, due to the deaths of Messrs. Johnston and West, and the illness of General Davis, and the general unsettled state of affairs existing on the Isthmus, owing to the reorganization of the Commission, it appeared highly desirable for me to return to Panama and to allow the question of personnel to be taken up at a later date.

If it was true that Mr. Dauchy was a competent man to carry on the work of organization and expansion of the organization, and keep a firm hand and overcome the panic and the confusion that was existing on the Isthmus, Mr. Wallace would have made him his assistant chief engineer, or principal assistant engineer, two officials provided for in his plan of organization. Instead of that, in his elaborate plan of organization, he retained him merely as resident engineer at Culebra. Nothing could more emphatically testify to the fact that Mr. Wallace did not regard Mr. Dauchy as equal to the position in which he left him.

Again, if this was the most opportune time, as Mr. Wallace says, that would be likely to come in the next year for him to leave the Isthmus, why was it necessary for him in his telegram to me to ask that he be ordered from the Isthmus? He answers this in his letter of June 8th, which I have already quoted above. He says:

The suggested order to return to the United States for a conference with you, prior to your leaving for the Philippines, was to cause a better effect on the men here than if they understood that I had returned of my own volition, as it would be natural to suppose that you might desire a personal conference with me in relation to the work here before your departure for a considerable absence from the country.

In other words, he wished me to enable him to present to the employees and workmen on the Isthmus a fictitious reason for his leaving the Isthmus. Why did he wish it to appear that he was not leaving the Isthmus at his own volition? Only one answer can be made to this, and that is that he knew that his leaving the Isthmus of his own volition would only add to the panic and the demoralization which existed on the Isthmus when he did leave. The truth was that the yellow-fever panic was at its height when he left the Isthmus; the number of cases, the number of deaths, and the number who ran away from the Isthmus on that account were highest in June when Mr. Wallace left.

The duty of the hour was to infuse esprit de corps into a frightened and stampeded force of employees, to house and feed an influx of 3,000 new employees, to take care of and distribute properly over the Isthmus a great amount of machinery and construction material, to clear an inadequate railway of greatly congested commercial business, and to perfect an organization with not half the needed leading assistants. This was the time which Mr. Wallace selected to retire for a vacation to study plans. The post of danger and responsibility and honor under such conditions was on the Isthmus, and it was no time to turn things over to a subordinate. In the letter of March 15 which Mr. Wallace wrote me, and which I have already introduced, he uses the expression "I prefer to remain on the firing line," indicating at that time, when he had no thought of leaving, where the post of importance was for the chief engineer.

I submit to the committee, in view of the facts that I have given, there is not the slightest support in this record for the astounding statement by Mr. Wallace which he made, first in his letter of June 8, again in the statement which he made to the press on July 30, and again in his evidence before this committee, that there was no time in the history of the construction of the canal when the chief engineer might better be spared from the Isthmus than when he left, on the 16th of June last.

In Mr. Wallace's evidence before the committee he does admit that there was demoralization after he left, but he says that my criticism of him at our interview which, with the approval of the President, I published, created the demoralization. I quote from his evidence:

And when Mr. Stevens arrived on the Isthmus, about the 1st of August, I have been informed that he found things in a very demoralized condition. Now, that was not due to my resignation. It was due to the treatment when I resigned, and also resulted from the fact that as the men that I left on that Isthmus had seen their chief discredited in a way, and knew that a successor was to fill his position that had been selected with an idea that everything that I had done was subject to criticism, there was not a man there that felt his place was secure, and the result was there was naturally complete demoralization.

Upon this point, Governor Magoon says in his report of March 20, 1906:

The difficulties and discomforts of the situation were many and distressing. Every one felt that Wallace had abandoned the situation, and that his action countenanced similar action on the part of others, and that the inevitable result would be that imperative action by the executive committee, which should be had at once, must of necessity be long delayed and probably deferred until such time as to make the action unavailing. Had means of departure from the Isthmus been immediately available, I believe we would have had both a panic and a rout. Before it was possible for any considerable number of our people to leave the Isthmus, the papers arrived containing the expression of views made by Secretary Taft at the time of his interview with Mr. Wallace in New York. The effect of reading this published statement was immediate, far-reaching, and beneficial.

The ordinary comment was, "Well, that ought to stop the cold-footed brigade," or some expression of like tenor. It brought to the attention of all of us what had been lost sight of in the general discomfort—that there was something more involved in the enterprise in which we were engaged than our personal comfort or personal advantage; it aroused the spirit which is so important to armies or other large bodies of men engaged in a common endeavor that they owed allegiance to the cause, and having once entered upon the accomplishment of a purpose they must of necessity sacrifice personal advantage to the public enterprise. There were many evidences that came to my knowledge and to my personal observation that the effect of the publications of the Secretary's remarks promoted, if it did not create, in the minds of the Americans on the Isthmus the sentiment to which I have referred.

Mr. Wallace deserted the Government at a time when his presence on the Isthmus was indispensable, and instead of making abundant provision, as he says, for the preservation of the interests of the Government, he utterly ignored those interests and selected a time for his departure that could not have been more disastrous. The great good fortune which we had in happening within three days upon Mr. Stevens and securing his acceptance was not due in any way to Mr. Wallace's intervention, and the dangers which were averted by this piece of good luck are not due in the slightest degree to Mr. Wallace's care or desire to save the interests of his employer which he had thus deserted.

It is said that I neglected the interests of the United States by dismissing Mr. Wallace and not availing myself of his offer to remain in an advisory capacity and give us the benefit of the studies which he had never committed to paper at that time, but which he proposed to commit to paper in the two months of contemplative retirement. I was not impressed with that suggestion at the time, and have not been since. However valuable his report, its loss would never have equaled the detriment to the discipline and esprit of the service, had he been permitted to retire from the post of danger and responsibility in such an emergency and yet thereafter to enjoy the prestige of association with the canal enterprise.

Mr. Wallace said in his defense published June 30, and in his evidence, that he was prevented by the presence of Mr. Cromwell from telling me all the real reasons for his leaving the office of chief engineer and refusing to go back to the Isthmus, and so contented himself with stating only one, to wit, that he had had a better offer. But in a letter which he wrote to Mr. Shonts on June 26, the day after the Manhattan Hotel interview, but before its publication, he says:

. . . The business proposition that I have now under consideration is of such an important character and opens out such a wide field for future prosperity to me that I cannot possibly see how I would be justified in declining it. My family and those of my friends with whom I have consulted with regard to it have been absolutely a unit in urging me to form the new connection.

Of course, both of these statements cannot be true.

Again, he says that one of his reasons which he did not tell me after leaving the Isthmus was, in effect, that he felt that he could not get along with Mr. Shonts, that Mr. Shonts was incompetent, and that he felt certain that in the future there would be a break between them, and that it was wise for him to leave in advance of that. Yet in this same letter of June 26th he said to Mr. Shonts:

I desire to express to you my warm personal regard, and my thanks for the kind and generous way in which you have treated me in all matters connected with the work, and to assure you that your personality had nothing whatever to do with the step that I am taking; in fact, in considering the questions from both sides, one of the strong inducements for me to remain was your pleasant personality and our warm personal friendship.

On the other hand, the probability of your being disconnected with this work, either in the near or immediate future, which seemed to come to me intuitively, and the probability of the position being filled by some man with whom I could not harmoniously act, was one of the strong inducements that controlled me.

Here again Mr. Wallace is refuted out of his own mouth.

It happened, as I have already said, that by the greatest good fortune, on behalf of the Philippine government I had employed Mr. John F. Stevens as consulting engineer to supervise the construction of railroads in the Philippines. Mr. Stevens had gone west to Chicago to make ready to go with the Philippine party to Manila. As soon as it was decided that Mr. Wallace would not continue as chief engineer I directed Mr. Shonts to make inquiry everywhere in regard to Mr. Stevens' qualifications as chief constructive engineer to build the canal. To my great relief the answers procured within two days were most satisfactory, and then the question was, Would Mr. Stevens accept? Mr. Stevens took time to consider, consulted Mrs. Stevens, and finally consented, at a salary of $30,000, to accept the responsible office. In this most remarkable way we succeeded in obtaining one of the very few men in this country capable of performing the task, although we had but two or three days in which to do it. Had we been as unfortunate in selecting a chief engineer for the work as Mr. Wallace was in securing his two chief assistant engineers we should have been delayed more than a year in finding the proper man.

Mr. James J. Hill, probably the greatest American railroad constructor, has told me that he has known Mr. Stevens for seventeen years, and that if we had searched the country over and every competent person had been willing to accept we could not have obtained a man better adapted to the peculiar work of building the canal than Mr. Stevens. Everything that Mr. Stevens has done since he has been in the employ of the Commission as chief engineer justifies this estimate of Mr. Hill, and I am sincerely thankful that at a time when everything seemed most dark and discouraging in the construction of the canal, and when the climax of trouble was reached in the retirement of Mr. Wallace, we were able to secure Mr. Stevens.

THE QUESTION OF LABOR.

With deference to the opinion of men much more experienced in the matter than I, I venture to say that we shall have to build the canal with tropical negro labor, expensive as it is. It may be that we shall secure Spaniards or other white men who are able to withstand the tropical sun, but at present I see but little prospect of it.

Chinamen do not make better laborers than other people when imported without their bosses or No. 1 men who have absolute control over them. They have been tried on the Isthmus before, and showed themselves quite subject to disease and also to discouragement leading to suicide. The negro labor of the West Indies is inexhaustible so far as our demands go, and it seems to me that we must rely on training them, eliminating the poor and rewarding the more industrious and competent. I do not think that Mr. Shonts and Mr. Stevens agree with me in this, and I am quite willing to follow them in any experiment within the law which will lead to a different result from that I anticipate. But this is my present judgment.

SHALL THE CANAL BE BUILT BY CONTRACT?

Of course the canal ought to be built by contract if it can be so built, and I think every one who knows about

the situation believes that ultimately it will be possible in the interests of the Government to make proper contracts; but I beg the committee in the discussion of this subject to bear in mind that at present it is utterly impossible to frame a law which shall be of any assistance in furthering the construction of the canal by contract. The Government is bound to proceed with construction for some time in order that it may itself learn the cost of doing work under the conditions that exist on the Isthmus, and in order that contractors may learn from the actual conditions the prices which they can afford to bid for the work to be done. Mr. Stevens told me that he thought it might require a year before all the plans and specifications for the work could be concluded.

He is now almost ready to begin work on the construction of the canal as soon as its type is determined, and the making of plans and specifications would not interfere at all with his proceeding upon the work, which does not need the completion of plans and specifications to begin and continue it.

Certainly a year, and probably more, must elapse before the time arrives in which invitations for bids should be prepared, and then six months or even longer time should be given, in order that possible bidders may have the opportunity to examine the Isthmus and make sure of the work they will have to do. If bids were opened now, bidders would be in the dark, and the result would be much higher prices because of the large element of risk due to lack of knowledge which would enter into the fixing of every bid, and thereby increase it largely. There is not the slightest disposition on the part of any one for the Government itself to build the canal. It will be much better to have the Government make the contracts and then use the chief engineer and such subordinates as may be necessary to supervise the work and see that the contracts are properly performed and their terms complied with. But there are many difficult questions to be settled as to the way in which such contracts ought to be let, whether the work ought to be divided, or whether the contract ought to be let as a whole. The Government would of course rent its plant to the successful bidder, and probably would have to turn over the railroad to him to run, complying with the charter as to commercial business. The necessity for the use of the railroad in the construction of the canal and doing the work which will have to be done by contract may lead to a unit contract, for it is difficult to see how different contractors spread along the axis of the canal route could all control and make use of the railroad without confusion and conflict.

CONCLUSION.

In this very long paper I have attempted to review the important questions which seem to have occupied the attention of the committee in its very patient and thorough examination. Had our foresight been as clear and wise as our retrospect may now be comprehensive and detailed, we might have avoided a number of mistakes. We have taken about two years to make the preparations necessary to begin the work of excavation. Those preparations have involved a great deal of preliminary construction and a great deal of persistent effort to make the Isthmus a healthy place in which our officers, employees, and laborers may live and work. There have been a great many difficulties to overcome in effecting a proper organization. As this is a governmental work and as every member of the public is entitled to know how it progresses, it has been subjected to a great deal of criticism, both just and unjust. It is impossible to compare the number of mistakes made in such preparation and organization with the number of mistakes that would have been made under private organization, for the reason that private corporate organization is not subjected to the fierce light that beats on a Government enterprise. The agents of a corporation are not held up to public obloquy by writers in the public press who can make but partial investigation into the facts and are consciously or unconsciously anxious to exaggerate and make sensational the faults of public servants. This one circumstance of the injustice and unfairness of public criticism through the press creates reluctance on the part of competent men to accept positions of responsibility in such an enterprise.

In spite, however, of all the difficulties, I feel confident, from the reports which come to me, that everything on the Isthmus under the most efficient administration of Mr. Shonts, Governor Magoon, and, most of all, Mr. Stevens, is in a condition that ought to commend itself to your committee. The enterprise is now organized on business principles and it is about time for the work of construction to begin. He would be a rash man who would assert positively and unequivocally that there had not been any waste of money or any corruption of any kind in the expenditure of some seventeen or eighteen millions under the conditions of distance and the sometimes necessary freedom from the closest supervision that have obtained in this work, but it can be affirmed that in spite of all the investigations, in spite of all the publicity given in various papers, as yet there has been no proof of corruption of any sort in the enterprise since the beginning, and I certainly hope that there is and will be nothing to justify such proof.

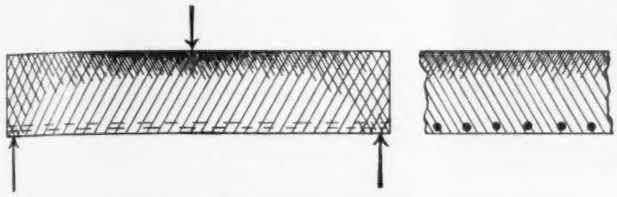


FIG. 1. SKETCH ILLUSTRATING VARIATIONS OF STRESS IN A CONCRETE BEAM.

A REINFORCED CONCRETE GIRDER HIGHWAY BRIDGE OF 40 FT. SPAN.

By Daniel B. Luten.*

A concrete bridge in the form of a reinforced girder is not ordinarily economical in cost or waterway when compared with a concrete arch, but when the abutments are already in place and a superstructure only is desired, an arch is usually out of the question and the girder becomes the only feasible construction. Such an instance occurred in the summer of 1905 near the town of Albany, Ind. A new bridge was required to replace a wooden truss on abutments which, although of rubble stone masonry, were considered sufficiently good for a new superstructure. Bids were requested on a steel truss bridge and on a concrete girder, both of 40-ft. span and 14-ft. roadway, with the result that in spite of considerable competition the bids on the concrete girder were the lower, and that of the National Concrete Co., of Indianapolis, was accepted at $540 for the complete superstructure.

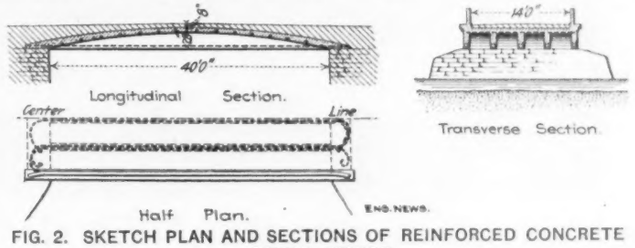


FIG. 2. SKETCH PLAN AND SECTIONS OF REINFORCED CONCRETE GIRDER BRIDGE.

The bridge has some unusual features in girder design, due to the attempt to secure maximum economy of material in order to meet steel bridge competition. Ordinarily, a beam is designed as a slab with parallel top and bottom surfaces. Such a beam is a very inefficient device, less than one-fourth of its material being subject to maximum allowable stress; in a column the efficiency of the concrete may be 100%, but in a concrete slab it cannot exceed 30%. Hence it is usually modified for long spans by embedding the tension members in girders projecting below the slab and leaving the upper surface a plane surface. On account of its added weight, no earth filling is ordinarily placed over such a structure, and the bridge is thereby made a very temporary affair, since the wear of travel is bound to break through the compression surface in the course of a few years, and if the break is not promptly repaired it will result in the destruction of the bridge. And such defects in our highway bridges rarely are repaired until too late. It is of prime importance, therefore, that the compression surface of the concrete should be protected from travel if the structure is to be any more permanent than a steel or wooden bridge. In the design of this bridge, therefore, allowance was made for a covering of earth and gravel over the upper surface of the concrete to a depth of at least 8 ins., and it was not then necessary to maintain a uniform level for the concrete surface.

Fig. 3. View Showing Forms and Concreting for Girder Highway Bridge.

Returning now to the concrete slab (see Fig. 1), the greatest compression occurs at the middle of the beam at the top and extends downwards in decreasing intensity to a depth of only about one-third of the beam. The lower two-thirds of the beam is in tension, which concrete is almost incapable of resisting and which should be carried wholly by the reinforcing steel. The upper parts of this slab towards the supports are also ineffective, since the bending moments decrease towards the abutments, and may consequently be resisted by a less depth of beam without increasing the intensity of stress. The effective portion of the beam is an area of compression of less than one-third the depth of the beam extending in a curve from support to support and tangent to the upper plane surface at the middle. The balance of the concrete in the slab is waste material, except where it serves as a protective coating for the steel.

To increase the efficiency, therefore, as much as possible of this waste material was eliminated by arching the floor from abutment to abutment, covering with earth filling to the required grade and embedding the tension members in suspended girders, five in number. The floor is reinforced at lower surface transverse to the roadway by ⅝-in. smooth steel rods at intervals of 3 ft. No longitudinal reinforcement was employed in the arch, since its extreme flatness reduces the bending moments, which are, moreover, resisted by the stiffness of the girders. Shear is to a large extent converted into direct compression in the arch, so that no shearing members are required other than the concrete and steel in the girders. Each girder has embedded at its lower edge about 8 sq. ins. of smooth steel rods in a straight line from end to end of the bridge and securely anchored over each abutment in the end of the arched floor. This type of bridge has some similarity to the bowstring girder, with its economy of steel members.

The maximum loading to be carried by the structure is a 20-ton concentrated load, besides 200 lbs. per sq. ft. of uniform live load and the dead weight of the structure and roadway. The bending moment at the center of span for this loading is estimated at 360,000 ft.-lbs. for each girder, producing a compressive force at the crown of about 145,000 lbs. and an equal tensile force in the steel at lower edge of girder. With 8 ins. of concrete at the crown, the intensity of stress in the concrete is about 500 lbs. per sq. in., and with 8 ins. of steel in each girder the intensity of tensile stress in the steel is about 18,000 lbs. per sq. in. These stresses are continuous at very nearly the same intensities from end to end of the girder, and the only waste material in the bridge is the concrete of the depending girders, which serves only as protective coating for the steel and to overcome the

*President National Bridge Co., Indianapolis, Ind.

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San Francisco is fortunate in having a greatly improved city plan all ready for its guidance in its rebuilding operations after the recent earthquake and fire. This plan was prepared after a careful study by Mr. D. H. Burnham, of Chicago, in behalf of the San Francisco Improvement Association. That organization is headed by ex-Mayor Phelan, so it may be assumed that Mr. Burnham's practical experience and artistic skill in city and landscape planning, combined with his study of local conditions and with Mr. Phelan's intimate knowledge of the needs of the city, will all work together for that better San Francisco which its citizens promised the world while the conflagration was still raging.

One of the most forceful lessons of the San Francisco conflagration was the lack of fire barriers in the way of wide streets and open spaces. It was that lack that made necessary the questionable resort to dynamiting. Not until Van Ness Ave., a relatively wide street, was reached, was the fire checked, and even there it broke across in one place, notwithstanding both the width of the avenue and the blowing up of costly residences by dynamite. In rebuilding the city this lack of fire barriers should be heeded. The Burnham plan, fortunately, provides for additional parks and wider streets, some of which, at least, would lend themselves to this very need.

Baltimore affords an illustration of the difficulties and disappointments attendant upon rebuilding a city after a large area has been cleared, or at least ruined, by fire. Many people, both citizens and outsiders, urged that the great Baltimore fire of 1904 afforded the city a splendid opportunity to reform its street plan and to secure a great advance in the character of its building construction. The net result of the efforts in both direction were discouragingly small. A little street widening, only, was done, and although many of the new buildings are of safer construction than those which they replaced, a large majority of them fall far short of what a modern city building should be in fire-resisting qualities.

A burned city is so handicapped by its losses and by its lack of dwellings, offices, stores and shops that the pressure is enormous to rebuild in the quickest possible manner, regardless of fire risk or other considerations. Apparently this pressure proved too much for the city council of Baltimore, since most of the proposed alterations in the street plan of the city and in its building code came to naught. The country expects different results from San Francisco. That city, like all those on the Pacific, possesses unlimited energy, and its citizens are used to bold ventures for the sake of future results. Then, too, the city has the Burnham plan all ready to serve as a guide in its rebuilding. And it has its Merchants' Association, an organization which for years past has been a powerful force in securing municipal improvements. Moreover, the very greatness of the losses at San Francisco favor rebuilding on improved lines. So much has been wiped out that over immense areas practically everything must be built anew, and, it would seem, there must be considerable delays in rebuilding on the part of many. These delays, unfortunate as they may be, will afford opportunities for deliberation and careful planning for the future.

Radical changes in the San Francisco building laws should be adopted as speedily as possible, and a competent commission on a remodelled city plan should be created. Naturally the Burnham plan would serve largely as its model, but the wiping out of Chinatown and other areas that formerly stood in the way of city development will afford opportunities to do many things that seemed impracticable when the Burnham plan was made.

A second acquittal in connection with the Philadelphia filtration contracts illustrates anew the principle that a municipal official should keep himself above suspicion. Mr. Frank Caven, a Philadelphia councilman, was accused of having been pecuniarly interested in filter sand subcontracts held by his father. After a trial lasting three days he was acquitted on May 2 by a unanimous jury verdict. The accused man admitted that he and his father had been in the sand and gravel business for a number of years and that as partners they signed an agreement with other sand contractors not to bid against each other on the Philadelphia sand contracts and to divide the profits, whichever party received filter sand contracts. Subsequently, after consulting counsel, Mr. Caven decided that it would be unwise for him to join in the sand contracts, since there were doubts in the mind of his counsel "as to whether a councilman could be a subcontractor." In due time, however, Mr. Caven voted, with other councilmen, confirming a large sand contract to J. McNichol & Co., and the contract was sublet to Mr. Caven's father. Mr. Caven appears to have represented his father in the handling of sand under the contract named, but it was not proved in the trial that he received any compensation therefor. During the construction of the filters a member of the editorial staff of this journal, while on a visit to some of the filters, was puzzled to know what Mr. Caven's relation to the filter sand contract really was, Mr. Caven having been introduced by one of the engineers of the Bureau of Filtration as a person who "is looking after our sand," or words to that effect, and it also being stated that he was a member of councils. There were only two interpretations to be put upon the words of this introduction: Either that a councilman was serving as sand inspector for the city or that he was in some way connected with the sand contract. Morally, there appears to be very little difference between entering into an agreement to control prices and share profits on sand contracts and entering into a subcontract which would have served to put the agreement named into effect. But law and morals, and particularly the morals of some representatives of both municipalities and private corporations, are very dissimilar.

Explosions in sewers near the southwesterly corner of Central Park, New York City, have been growing alarmingly frequent of late. The cause for alarm is all the greater because it is believed that the explosions are due to the discharge of gasoline into the sewers at automobile stations. This means not only possible injury or death from flying manhole covers but also possible harm to buildings and other occupants from explosions and from fire and also the likelihood that the sewers themselves will be shattered. Damage to the sewers from these explosions might lead to stoppages or to leakages, or both, thus flooding cellars and polluting the ground. The Board of Aldermen of New York have very properly passed an ordinance imposing a fine of $50 on any one who allows explosive liquids or gases to be discharged into the sewers from his property. More severe penalties would not be out of place.

PANAMA CANAL PROSPECTS AND PLANS.

In the exceedingly interesting statement recently made by Secretary Taft to the Senate Canal Committee, which we publish in this issue, he urged the committee if it intended recommending a change to the sea-level type canal to do so promptly, and stated that otherwise the Administration would proceed with the construction of a lock canal under the authority given by the Spooner law.

Washington dispatches to the "Evening Post" of May 3 and the "Journal of Commerce" of May 4, indicate that in all probability the Senate Committee will not report any legislation at this session looking to a change in the type of canal, but will leave the Administration free to proceed with the work on the general lines laid down in the Minority Report of the Consulting Board. It is stated that the lock canal is favored by Chairman Millard and Senators Platt, Dryden, Hopkins, Knox and Simmons and probably also by Senator Ankeny. The only members of the committee who appear to have been impressed with the arguments of the sea-level advocates are Senators Kittredge, Taliaferro and Gorman, the last of whom has attended comparatively few sessions of the committee. Senator Morgan, who has been diligently seeking some ground for compromise between the sea-level and the lock plans has introduced a bill in Congress by which he proposes to extend the sea-level section on each side nearly up to the summit cut, which he would pass over at an elevation of 85 ft. Such a canal would have, of course, as much lockage as the one which the Administration proposes, and the sea-level sections at each end would cost far more to construct. The proposal, therefore, will hardly receive serious consideration.

Even should the Senate Committee at this late day report in favor of the sea-level plan, the result would probably be only delay to the entire enterprise, and consequent disappointment to all friends of the canal project. The House committee on the canal is said to be strongly in favor of the lock canal; the position of the Administration is well known. It may be safely assumed, therefore, that such staunch supporters of the President as Senators Knox and Hopkins, to say nothing of other well-known members, will not take ground in opposition to the Administration on this most vital matter unless convinced beyond question that the lock-canal plans are defective.

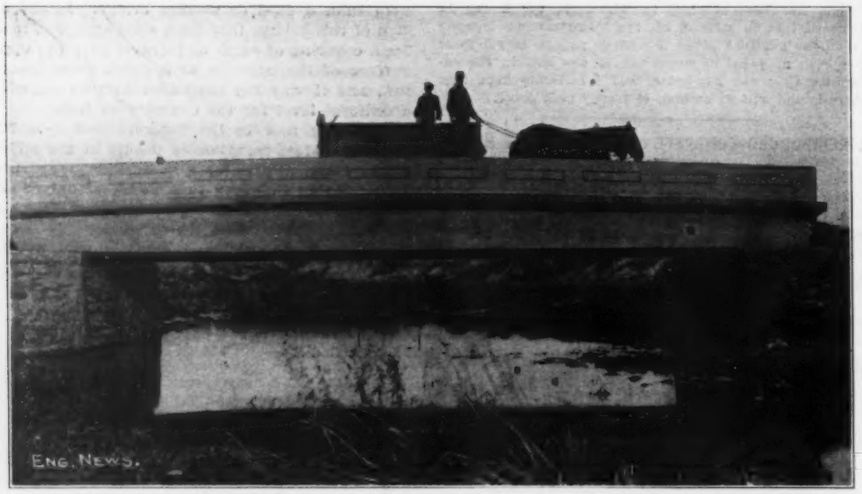
We have followed carefully the testimony of the various experts who have appeared before the Senate Committee during the past four months, and we are unable to find that in any important particular the lock-canal plan, recommended by the Minority members of the Consulting Board and adopted by the Canal Commission, has been proved to be faulty.

It has been claimed, for example, that the sailing route through the Gatun Lake would be silted up by the sediment carried by the rivers flowing into Gatun Lake; but the same engineers who have brought forward this argument are the ones who drew the portentious picture of the Gatun dam being undermined by the rush of water through the alleged permeable strata beneath it, and they omitted to mention the effect of that same sediment in sealing the bottom of the Gatun reservoir.

There have also been estimates of many million dollars as the cost of the land to be flooded by the Gatun dam, and these estimates have been based on prices of small tracts of land in the vicinity of Panama or Colon. No mention has been made of the fact that the United States under the exigencies of its sanitary and preparatory work might very well submit to extortion,

slight shearing stresses that may be developed by the live loads.

Since the erection of this bridge it has become apparent that more girders were introduced than were necessary, and that two girders, one at each face, would have been sufficient; nor would the arched floor have required a very great increase in reinforcement, since its curvature from a spiral, of which one complete revolution will usually prove more than sufficient. That this anchorage proved satisfactory in the 40-ft. girder is evidenced by the fact that the settlement when centers were removed was but 1-32-in., and a careful examination of the depending girders showed no cracks. A square turn or an upset end will not develop one-tenth of the strength of



REINFORCED CONCRETE GIRDER HIGHWAY BRIDGE OF 40-FT. SPAN NEAR ALBANY, IND.

abutment to abutment would prevent its collapse, provided satisfactory provision were made to transmit the thrust at the abutments to the two outside girders. And this is easily provided by the anchorage used in this bridge for the tension rods. Each rod is curved sidewise at its end and extended across the ends of the girders to form a transverse bond from side to side of the bridge at the abutments. The rods in this bridge were extended far enough only to hook over or lap past the rods of the next adjacent girder, but if intermediate girders are to be omitted, some of the rode from each side should be extended all the way across to the other face girder.

The anchorage used in this case was simple and yet very effective, and since it admits of broad application to any case where the full strength of the steel is to be anchored in a limited area of concrete, it merits further discussion. The secret of its success lies in the method of making the bend in the rods. In Mr. Harding's paper on reinforced concrete beam tests in the December, 1905, Journal of Western Society of Engineers (see Engineering News, Feb. 15, 1906), rods are shown anchored by a right angle turn of 3 ins. at their ends. In discussing this paper, Professor Talbot calls attention to the fact that since these rods are embedded in a slab beam similar to Fig. 1, there can be no tension at their ends, and the anchorage consequently received no test. Professor Talbot continues:

> If we so design a beam as to get uniform stress throughout the rods the whole stress must be communicated at the end of the bar to the concrete by some form of anchorage (we cannot use pin connection as in a bridge truss), and the question of anchorage in such a case as that would be quite a problem.

A right angle turn, or any sharp bend, would prove an inefficient anchorage, for the reason that only a fraction of the strength of the rod could be developed before the concrete at the sharp bend would crush.

In the girder Fig. 2 the tension is nearly uniform from end to end of the rods, and is intense, amounting to from 15,000 to 20,000 lbs. per sq. in. But the ends of the rods are bent around a curve having a radius of about 10 to 15 times the diameter of the rods, so that at no point will the normal component of the tension in the rod exceed the crushing strength of the concrete. Theoretically, all that is required to securely anchor a rod or bar to its full capacity is to bend the end to a curve or radius sufficiently large to prevent crushing, and since the adhesion rapidly reduces the tension, the curve takes the form of the rod, and, while economical in steel, there are other and better ways of economizing in steel reinforcement if a secure anchorage is essential.

This question of anchorage may be better understood by a comparison with a steel in wood anchorage. Suppose it be desired to develop the full strength of a steel rod by wrapping its end around a wooden post with no bearing plates. To wrap the steel rod around a square post would simply result in crushing the corners of the post when the pull was applied; but one or two turns around a round post would hold the rod, provided the post were of sufficient diameter to prevent crushing.

The anchorage and other features of the design are shown in Fig. 2, and the completed bridge in the front-page picture. Fig. 3 is a view of the falsework when the bridge was half completed. The total yardage of concrete in the completed bridge is 38 cu. yds.

Mild steel was used for the ties in preference to high-tension steel, for the following reasons: The moduli of elasticity being approximately the same for the two kinds of steel, the elongation in the steel will be the same for a given stress; and since visible cracks appear in the concrete when the steel is stressed above 20,000 to 25,000 lbs. per sq. in. it is rarely, if ever, desirable to exceed that stress. The higher tensile strength of the hard steel is then only a factor of safety, which is always fully provided for elsewhere. Most high-tension steel, moreover, is rerolled from old steel rails, producing a steel of very doubtful quality, so that the use of such steel might transform our superfluous factor of safety into a factor of danger instead.

Immediately on completion of the concrete work (with the exception of the railings) the roadway was graded and graveled and the bridge thrown open to traffic. Twenty-five days later the centers were struck, removing the supports under the middle of the span first and working towards the abutments. The 6-in. concrete railings, which were considered too light to sustain any of the compression that might result from settlement, were then added; they are 24 ins. high and curved outwardly at each end 6 ins., as shown on the plan Fig. 2; the 12-in. spandrel, however, is straight, to facilitate erection. The coping and railing was given a camber of 6 ins., but the appearance would probably have been improved had the camber been but an inch or two instead of six.

The area of waterway is amply sufficient for this location, but as the bridge has a depth of 3 ft. 8 ins. from road surface to lower face of girder, it would not be as satisfactory as an arch for a location where the waterway would be an important consideration, as is usually the case.

The plans, working drawings and all steel for reinforcement were supplied by the National Bridge Co., of Indianapolis, for the lump sum of $145.

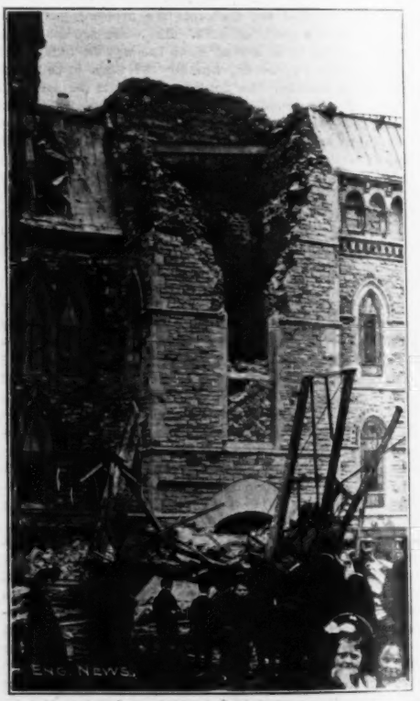
THE COLLAPSE OF THE PARLIAMENT BUILDINGS TOWER, OTTAWA, ONT.

By J. A. M.

The accompanying view shows the appearance, after the collapse, of the masonry tower on the Western Departmental Block of the Parliament Buildings at Ottawa, Ont. The collapse occurred on April 5, 1906, as described in Engineering News of April 12.

The government has appointed Messrs. Hutchinson and Curry, two Toronto architects, to report on the cause of the collapse. The commission ordered the standing portion of the tower to be torn down, and work to that end was immediately begun by Mr. George Goodwin, the contractor for the tower. As the tower was being torn down instances of bonding were noted, which tend to disprove some of the charges made against the contractor.

At a hearing held by the commission Chief Architect Ewart was examined. He stated that the specifications had not been followed in the north and east walls, and that the stones had not been properly bonded. He had placed Mr. Taylor, his assistant, in charge and given him all the responsibility of inspecting the work. When the foundation was being built Mr. Ewart found something wrong with the concrete work, and placed a man on watch. This man left at the completion of the foundation. In the past it had been the practice to employ a clerk of



View of Wrecked Masonry Tower, Western Department Block, Parliament Buildings, Ottawa, Ont.

works, but owing to complaints of Parliament about the alleged unnecessary cost of a clerk, the practice was changed. In reply to the commissioners, Mr. Ewart gave it his opinion the cause of the tower falling was (1) lack of bond stones; (2) improper construction; (3) and largely, winter work.

are the centers for the curves of the five-centered arch, and K A, M H, and O I are the radii.

The corresponding formulas (see Fig. 2) are:

Let the span A B = b
rise C D = a

and the desired radii O I, M H, K A = R_1, R_2, R_3.

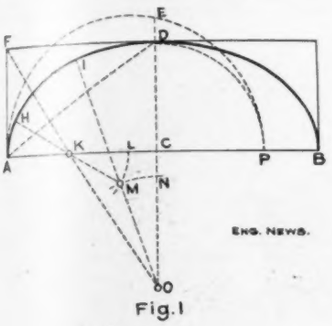


Fig. 1

Then

$$R_1 = \frac{b^2}{4a}$$

$$R_2 = \frac{2a^2}{b}$$

$$R_3 = \cos \varphi \left(\frac{\frac{1}{4} b + a}{2} \right)$$

where φ is given by $\sin \varphi = \dfrac{\frac{1}{4} b - a}{\frac{1}{2} b + a}$

$$OM = R_1 - R_2$$

$$KM = R_2 - R_3$$

$$OK = \frac{R_1 - a}{\cos FOD}$$

where FOD is given by $\tan. FOD = \dfrac{2a}{b}$

The three preceding values are to be substituted in the following two equations,

$$\cos KOM = \frac{\overline{OK}^2 + \overline{OM}^2 - \overline{KM}^2}{2OK - OM}$$

$$\sin KMO = \frac{OK}{KM} \sin KOM$$

Then

Angle IOD = FOD − KOM = ½ △1
Angle HMI = 180° − KMO = △2
Angle AKH = 90° − (HMI + IOD) = △3

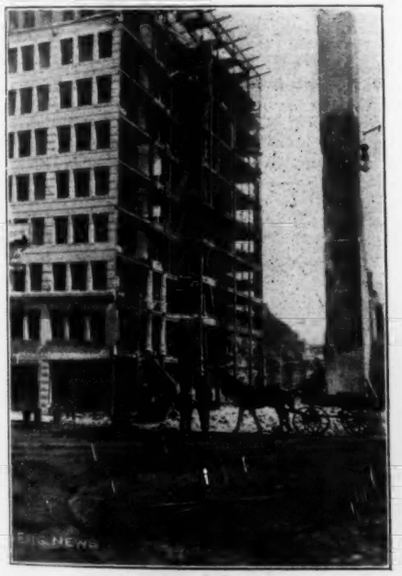


Fig. 1. Monadnock Building and Chimney of Examiner Building.

The length of the chords and the arcs A H, H I, I X, are found by the formulas:

$$\text{Chord} = 2 R \sin \tfrac{1}{2} \triangle$$

$$\text{Arc} = \frac{\triangle}{360^\circ} 6.2832 R$$

Yours truly, A. Swarts.
Chief Draftsman.

Office of Chief Engineer, Erie R. R. Co., 26 Cortlandt St., New York, N. Y., March 31, 1906.

VIEWS OF SAN FRANCISCO BUILDINGS SHOWING EFFECTS OF FIRE AND EARTHQUAKE.

The accompanying twelve views of San Francisco buildings that underwent the shock of earthquake and the following attack of fire have

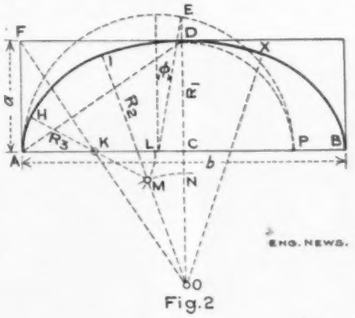


Fig. 2

been furnished us by Milliken Brothers (Inc.), of New York City. The photographs were taken only a few days after the fire by the San Francisco representative of the firm named, and the views were selected to show the condition of individual prominent buildings rather than to illustrate the general effects of the disaster. The following explanation of the several views is furnished by Milliken Bros.:

Fig. 1 shows the unfinished end of the Monadnock Building, for which we furnished the structural steel work. This end of the building was to be built up, but for some reason connected with the title to the property the steel work had not yet been erected. The chimney on the right shows the remains of the "Examiner" building. A peculiarity of the fire is shown by the wooden ladders on the Monadnock Building, which you will notice are uninjured.

Fig. 2 is a view down Geary St. from Polk St., looking east and the Call Building can be seen in the far distance.

Fig. 3 is from a photograph taken looking down Geary St. from corner of St. Francis St., showing an uncompleted 15-story building.

Fig. 4 shows the Hayward Building, for which we had the pleasure of furnishing the structural steel work some years ago. This building was practically uninjured by the fire. The Merchant's Exchange, however, which is shown on the right of the picture, was completely gutted by the fire.

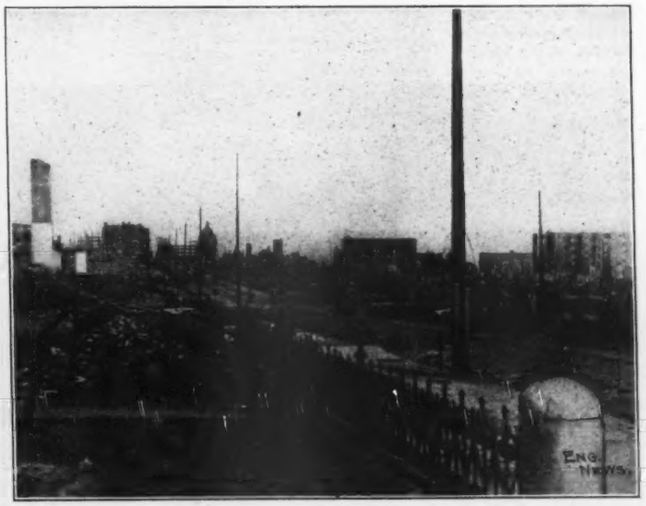


FIG. 2. VIEW EAST ALONG GEARY ST. FROM POLK ST.

Fig. 5 is from a photograph taken down Geary St. east, near Kearney St. In the center is shown the Palace Hotel. The Monadnock Building, already referred to, is shown on the right of the Palace Hotel, and a portion of the Mutual Bank Building is shown still further on the right. The Chronicle Building is shown on the left.

Fig. 6 shows the Ruef Building, for which we furnished the structural steel. This building is entirely uninjured, and was in course of construction at the time of the disaster.

THE PLANS AND ORGANIZATION FOR THE PHILIPPINE RAILWAY SYSTEM.

The following brief account of the plans for the proposed railway system to develop the Philippine Islands and of the organization that will have the work of development in hand is furnished us by J. G. White & Co., of New York City. This company being one of the principal members of the syndicate which is to finance the work, and also being the firm that will have in charge the work of engineering and construction, makes the information given practically official.

The new system of railroads in the Philippine Islands will cost $30,000,000, and is to be built by private American capital, under concessions granted by the Insular Government. It has already been arranged that the system covering the Islands of Panay, Negros, and Cebu shall be financed and built by a New York syndicate, composed of Cornelius Vanderbilt, J. G. White & Co., William Salomon & Co., and associates. There will be included in the system about 400 miles of track, almost equally divided between the three islands. The plans of the Government provide also for a system of equal size on the island of Luzon, but the concession has not yet been awarded. Speyer & Co., of New York, are the principal bidders.

In the case of both awards, the franchise is perpetual, and the Government guarantees interest at 4% on 95% of the bonds for 30 years. This railroad development is the most important project in the future plans of the Government for promoting the welfare of the Philippines, and it will substantiate in an important degree the promises made by the United States to the world for the regeneration of the island possessions. The engineering and construction under the concession already granted to the above mentioned syndicate will be done by J. G. White & Co., of New York, who are thoroughly established in the Philippines, having been the engineers and constructors of the Manila St. Ry., the first big investment of American capital in the islands, amounting to $6,000,000. The Manila street railway and lighting system is the most extensive electric service plant in the Far East. The company has continued its connection with this property in the capacity of operating manager for the Manila Electric Railroad & Lighting Corporation, which is the holding organization. Among the other important engineering developments previously undertaken for the Government by J. G. White & Co. are the Cebu and Iloilo harbor improvements, consisting of dikes, sea-walls and dredging, costing $1,000,000, and the coaling station at Olongapo, Subig Bay, a part of the new Far Eastern naval base, which will be the most completely equipped naval headquarters in the Far East. There will be six coaling units, practically in duplicate, and consisting each of a massive concrete and steel pier, and a large coal storage shed and elaborate coal handling apparatus, with a capacity of 400 tons an hour. Each unit will cost $500,000.

The harbor improvements nearing completion at Iloilo and Cebu form a part of the system of transportation, of which the railroad lines now to be built constitute the principal feature.

The organization of the pioneer corps for the railways has practically been completed, and the first division sailed for Manila from Seattle on April 29.

The Chief Engineer of the Philippine Railways is Mr. Edward J. Beard, formerly principal assistant engineer of the Chicago, Rock Island & Pacific R. R., who has figured prominently in the railroad development of the West. It is believed that the selection of Mr. Beard for the work is very fortunate. He combines in an unusual degree the qualities of generalship and the genius for detail. The present party of 50 engineers was selected on the basis of two considerations, the more prominent members have nearly all been chosen for special experience in the projection of railway and engineering enterprises abroad on the frontier of civilization, but the rank and file selected from the railroad field of the West is composed principally of young engineers who are known to Mr. Beard personally from their association with him in Western railroad work.

Some of the well-known engineers selected on the basis of the first consideration of special experience abroad

where the total sum concerned was only a few thousand dollars, when if thousands of acres were to be taken and millions of dollars were at stake, it would be well worth while to make a stand and pay for the land only its actual value.

The lock-canal plan has been criticised also because of alleged insufficient traffic capacity; but the analysis of the probable future volume of canal traffic given in our issue of April 19 should convince any unprejudiced engineer that the lock canal can handle easily all the traffic that will seek it until a period too far in the future for us at the present day to take into practical account.

There remain still two criticisms of the lock canal which may be considered as appealing with more or less force to engineers. It may freely be admitted that the ordinary and usual way to build a dam is to excavate to bed rock and carry an impervious wall of masonry or puddle from a water-tight junction with the bed rock clear to the crest of the dam. The average engineer is still unfamiliar with the theory and practice of earth dam construction on soft foundations; and it is not surprising that some members of the profession have hesitated at the plan for an earth dam to sustain 85 ft. head of water, with a great depth of more or less permeable earth beneath it. Still less is it surprising that some members of the Senate Committee have been impressed with the sweeping criticisms on the design of this dam which have been made by the sea-level plan advocates.

The other criticism to which we refer relates to the three locks in flight at Gatun. While we do not attach the importance that Mr. Parsons does to the possibility of a vessel breaking through one of the upper lock gates and thus draining the summit level of the canal, any engineer will admit, of course, that in a great interoceanic ship canal it is preferable to have locks separated instead of placing them in flight. There is, moreover, an additional advantage in separating the lock in that construction can be carried on more rapidly when thus divided. In the Minority report, the estimate of the time necessary for building the three-lock flight at Gatun, was set at the same period as the excavation of the Culebra cut.

These considerations lead us to bring forward at this time the suggestion of an alternative plan of construction for the lock canal, consisting briefly in lowering the height of the Gatun dam to 60 ft., placing a two-lock flight instead of three locks in the hill beside it, and locating another dam and lock at Bohio, to sustain a net head of 25 ft. in the summit level lake behind it.

This proposed plan is, of course, not novel. It was in fact favored by Gen. Abbot of the Consulting Board of Engineers in preference to the plan adopted by the other minority members. (See Engineering News, March 1, p. 234.) We do not bring it forward here to advocate it as superior or preferable to the adopted plan; but to point out its tactical advantages in meeting the only important criticism which the sea-level advocates have been able to make of the lock plan.

With the head against the Gatun dam reduced to only 60 ft., certainly no possible doubt could remain in the minds of any engineer as to its absolute stability, and there would be naturally a great reduction in its cross-section, volume and cost. The advantages in a two-lock flight at Gatun instead of three have just been noted. At Bohio, it will surely be granted that a dam to sustain a net head of only 25 ft. can be made without any necessity of deep excavation to impermeable strata. This dam could certainly be, therefore, a very small and inexpensive structure. The lock site in the ridge at Bohio is already partially excavated and the Gigante spillway would play the part assigned it by the Commission of 1901. In addition it may be noted that the area of the land to be flooded, with consequent land damages, below Bohio would be much reduced, which should comfort the critics who have been worried over this matter.

On the contrary side, however, we must set the fact of the greatly reduced water supply and storage area for the summit level under this plan. It would doubtless be necessary to build a great dam at Alhajuela to store water for the dry season and regulate the summit level, or perhaps even to build the dam at Gamboa; but by building either of these dams at once, a valuable water power would be secured which could furnish electric current for light and power all through the construction of the canal. In addition, the flood control of the Chagres, which such a dam would afford, would greatly facilitate the work of construction at Bohio and Gatun, and might easily effect a saving of cofferdams, etc., that would pay a considerable part of the cost of the permanent dam.

Again the smaller lake above the Gatun dam would not set back tributary streams so far, and there would be more likelihood of sediment reaching the sailing line. It might even be necessary to build small dams on some of the larger streams like the Trinidad to impound the sediment; but according to the sea-level advocates such dams could be built at no great expense.

So far as the completed canal is concerned, reference to the map and profile shown in our issue of Feb. 22 will make it evident that the smaller and shallower Gatun Lake would still be deep enough from Gatun nearly all the way to Bohio to afford free navigation with very little preliminary excavation. Above Bohio the channel depth and width would be the same, of course, as for the plan now adopted.

We have said above that the Administration will proceed, unless Congress directs otherwise with the construction of the lock canal, under the authority given by the Spooner Act of 1902. This does not mean necessarily that the exact plan laid down by the minority members of the Consulting Board will be followed in every detail. While the Canal Commission has adopted this plan in a general way, it is nevertheless entirely free to make such variations from it as wider knowledge and more thorough study may show to be advisable. For example, a spillway over a low divide from the Gatun Lake may be chosen instead of one forming part of the Gatun dam; and it is entirely within the power of the Commission to make such a change as is proposed above with reference to the dams and locks on the Atlantic side, instead of following the exact plan proposed by Messrs. Stearns, Noble, Randolph and Ripley.

We have already expressed in these columns our full approval and confidence in this plan, and the above suggestion of a departure from it is proposed by us only as a concession to criticisms which have been made and not as an improvement on the original plan. Whether it is or is not politic to make such a concession, must be left for circumstances to develop.

LETTERS TO THE EDITOR

The Strength of Riveted Joints.

Sir: In your issue of to-day Mr. Godfrey quotes a clause of my specifications in regard to the proper net section of a riveted tension member and expresses the opinion and attempt to prove it be "unfair" and "irrational."

I would respectfully refer him to the very excellent and full investigation of the Research Committee of the Institution of Mechanical Engineers, England, on riveted joints for my authority. "Proceedings Inst. Mech. Engrs.," April, 1885, or "Engineering," July 3 and 10, 1885. Theodore Cooper.

45 Broadway, New York, May 3, 1906.

Vertical Curves for Electric Railway Track.

Sir: I desire to inquire through the columns of your journal what is a proper requirement to insert in specifications for electric railway construction for vertical curves at grade intersections. On steam railways it is well known that very long vertical curves are demanded at grade intersections to avoid strains on the couplings of long and heavy trains; but this consideration does not apply at all to electric railways running single cars. An additional reason for easy vertical curves on steam railways is to avoid too great variation in the load on different axles of long consolidation or decapod locomotives; but this again does not apply to electric roads.

I would like to know, therefore, what limitations there are, if any, to the use of sharp vertical curves on electric roads, particularly lines where no high speed running will be done. So far as I can see, except for easy running at good speed, there is no reason why an electric car cannot run over a track in which no vertical curves at all are used at grade intersections; but I would be very glad to be informed as to the practice of other engineers. "Vertical Curve."

Cincinnati, April 28, 1906.

Effect of the San Francisco Earthquake on a Reinforced Concrete Building.

Sir: You will no doubt be interested in the attached copy of letter received from Mr. R. W. Hart, Architect, of San Francisco, regarding a reinforced concrete building which was being erected in accordance with the Kahn system in San Francisco at the time of the earthquake.

Very truly yours,
Trussed Concrete Steel Co.,
A. Gregory.

Detroit, Mich., May 4, 1906.

Dear Sirs: You may be interested to know that the warehouse I have under construction here, using your bars, is up two stories—the third floor slab being finished four days before the earthquake—and that not a crack of any kind is visible in the columns of first story or beams and slabs of second floor. I made as careful an examination as possible, from the floor, and am more than delighted with its condition.

Because of the influence of the brick layers' union the city authorities refused us a permit for this building until we conceded brick walls. These walls are so badly cracked that probably one-third of same must be rebuilt. If we had had reinforced concrete outside walls I am confident that the earthquake would have done no damage whatever to this building.

Yours very truly,
R. W. Hart, Architect.

2903 Clay St., San Francisco, Cal., April 23, 1906.

A Caisson Tunnel Invented by the Elder Trautwine in 1876.

Sir: Noting recent descriptions and discussions in Engineering News of subaqueous tunnel work where the tunnel is constructed in sections on land and afterwards sunk in place, I have thought you might be interested in the fact of my father's patent (long since expired) No. 181,498, August 22, 1876, for "Sub-aqueous tunnel."

I enclose a copy of the patent, and a blue print from the single figure accompanying it.

As you will see, the patent covered the two essential features, viz.:

(1) Construction in sections on land.

(2) The closing of the ends of these sections by temporary water-tight bulkheads.

Yours truly, John C. Trautwine, Jr.

257 South Fourth St., Philadelphia, April 20, 1906.

[We quote the following extracts from the specifications of the above named patent.—Ed.]

My invention relates to the economical construction of subaqueous tunnels for railroads or common roads; and my improvement consists in constructing the tunnel above water and upon a strong wooden platform, which shall serve as the base of the tunnel after the latter has been sunk and placed in its final position in the water.

According to circumstances the tunnel may at first be constructed either in one length only, or in sections, to be placed under water separately. In the latter case the ends of such sections may be temporarily closed by bulkheads, which may be removed after the junctions of said sections have been completed by divers, or by the aid of cofferdams or otherwise.

The foundations upon which the tunnel is finally to rest must be prepared for it before the tunnel is sunk into its place, and may (according to circumstances) be either at or above or below the natural bottom of the water. This foundation may be prepared by any of the methods usually adopted for bridge piers or other subaqueous structures.

Tunnels constructed in this manner will avoid the hazardous and costly excavation, and other processes involved in working below the bed of the water, and inasmuch as they need not be placed at as great depths as the ordinary process demands, their length and that of their approaches may usually be much reduced thereby, reducing also their cost.

I claim as my invention the mode herein described of making subaqueous tunnels, that is to say, the building of the tunnel above water on a platform, and the sinking of both, so that the said platform shall form the permanent base of the tunnel, all substantially as herein set forth.

A Graphical Method for Laying Out a Five-Centered Arch.

Sir: I beg to enclose you the description of a graphic method of laying out a five-centered arch, and also the solution of the problem reduced to a formula.

This matter lately came up in my office, and never having seen any simple formula for a five-centered arch, I worked it out with the help of one of the draftsmen. Thinking that this will probably be of use to some other engineers, I am glad to submit it.

To plot the intrados of a five-centered arch, having given the span and rise.—Let A B (Fig. 1) represent the span and C D the rise. Join D and A. Draw F O perpendicular to D A. Make C P = C D and describe a semicircle P E A on A P. Make C N = E D and describe arc M N from center O. Make A L = C E and describe arc L M from center K, cutting M N at M. Then K, M and O

are the following: P. H. Ashmead, H. F. Howe, C. H. Farnham, J. M. Robinson and L. E. Bennett. Mr. Ashmead, Mr. Howe and Mr. Farnham have all been connected recently with the Canton-Hankow Railroad development in China. The Canton-Hankow R. R. is the southern half of the proposed great trunk line through Southern China from Canton to Pekin, the northern half of which, the Canton-Pekin road, is already in operation. Mr. Ashmead was appointed by J. P. Morgan & Co. to represent them in the negotiations for turning over the property to the representatives of the Chinese Government. He was formerly chief engineer of the road. Mr. Howe was recently acting Chief Engineer, and Mr. Farnham was Division Engineer and Superintendent of Construction of the San Shui Division. Mr. Robinson has been Locating Engineer of the Guayaquil & Quito R. R. through the Andes in Ecuador, which involved some of the most daring mountain railroad building ever undertaken. Mr. Bennett is widely experienced in the management of engineering enterprises in the Far East, and was assistant to Governor Taft in outlining the transportation plans of the Government in the Philippines, which are now being put into execution. Previously Mr. Bennett was selected engineer to the Emperor of Siam for railways and irrigation. Among those selected from the railroad field of the United States are C. J. Hogue, late Superintendent of Maintenance of Way on the Choctaw District of the Rock Island; Mr. F. D. Nash, recently in charge of 50 miles of reconstruction on the Burlington System; and Mr. C. H. Hill, of the Michigan Central Ry. From the foregoing, the high standard of the organization is at once apparent.

All the minor positions in the work of survey, rodman, axeman, tapeman, etc., will be filled by native Filipinos to the number of several hundred. Whenever they show sufficient aptitude, natives will, however, be advanced to more responsible position in accordance with merit. With the confidence gained through previous undertakings, entire dependence will be placed upon native Philippine labor for the work of construction. It is expected that some ten to fifteen thousand native Visayans will be employed during the four years required to complete construction.

For locating purposes, the present party will be divided into five sections, three for Panay, and one each for Negros and Cebu. Work will be commenced simultaneously on the three islands, but that on Panay will be pushed to completion first. Plans for the construction equipment are already well advanced, and such equipment as must come from home will follow as required. However, a great deal of the construction machinery outfit can be made up from the extensive construction plant of J. G. White & Co. in Manila, Iloilo and Cebu.

THE LOW UNIT-STORAGE COSTS OF SOME U. S. RECLAMATION SERVICE RESERVOIRS.

Contrary to the expectations of some and the fears of others the cost of the large irrigation works now being constructed in the West by the U. S. Reclamation Service is proving to be low, as compared with cost figures in the East. At least, such is the opinion of the Service, according to a statement just issued in which it compares the unit-storage costs of certain reservoirs in the two parts of the country. We quote as follows, and call attention to a few words of comment following the quotation:

If we take, for example, the three great masonry dams now being erected for the purpose of storing water, viz., the Roosevelt dam in Arizona, the Pathfinder dam in southeastern Wyoming, and the Shoshone dam in northwestern Wyoming, we shall find that the effective storage capacity costs are far below those of some of the great eastern dams, like the New Croton in New York, and the Wachusett in Massachusetts. The heights of these dams are as follows: Roosevelt, 280 ft.; Pathfinder, 210 ft.; Shoshone, 308 ft.; New Croton, 297 ft., and Wachusett, 207 ft. These heights are measured from the foundation stones to parapet in each case, and they show that the Shoshone is the highest, while the New Croton is second and the Roosevelt third. If, however, the height above the river bed be considered, that is, the effective storage height, the New Croton is the lowest. The order is then as follows: Shoshone, 240 ft.; Roosevelt, 230 ft.; Pathfinder, 200 ft.; Wachusett, 185 ft., and the New Croton, 157 ft. In other words, about 50% of the masonry in the New Croton dam is below ground and is serviceable for foundation purposes only.

It is interesting to note the comparative reservoir capacities. While the New Croton dam is the largest in the world from the standpoint of its amount of masonry, the storage capacity of the reservoir formed by it is by far the lowest of any of those above mentioned. In fact, from a standpoint of storage economy, the New Croton reservoir is one of the poorest that has been constructed in recent years. The dam contains 833,000 cu. yds. of masonry and was erected at a cost of $7,600,000. The capacity of the reservoir formed by it is 4,000,000,000 cu. ft., or a cost of $1,900 per 1,000,000 cu. ft. storage. Similar figures for the Wachusett dam show that it contains 280,000 cu. yds. of masonry, and was erected at a cost of about $2,000,000. Its storage capacity is 8,400,000,000 cu. ft., or a cost of $238 per 1,000,000 cu. ft. storage. In contrast to these excessive costs the three western dams appear remarkable. The Roosevelt dam, for example, contains 350,000 cu. yds. of masonry, erected at a cost of $3,850,000. The capacity of the reservoir is 61,000,000,000 cu. ft., or fifteen times that of the New Croton, and about 7½ times that of the Wachusett. The cost of this dam per 1,000,000 cu. ft. storage is only $63.16. Even more remarkable appears the Pathfinder dam. It contains 53,000 cu. yds. of masonry, erected at a cost of $1,000,000. The capacity of the reservoir is 43,560,000,000 cu. ft., or more than ten times that of the Croton. The cost of the dam per 1,000,000 cu. ft. storage is therefore only $22.95, as against $1,900 for the New Croton, and $238 for the Wachusett. Similar figures for the Shoshone dam, the highest in the world, are: Cubic yards of masonry, 60,000; cost, $1,000,000; capacity of reservoir, 20,000,000 cu. ft.; cost per 1,000,000 cu. ft. storage, $50.35.

These extremely low costs have seldom been equalled in the history of reservoir construction, and are due largely to the excellent natural facilities which are found in the rugged western country. From this fact it must not be inferred that these western structures are simple engineering works. On the contrary, owing to their isolated location, their inaccessibility by rail and often by wagon, and the erratic and torrential character of the streams, they involve problems which tax the skill and ingenuity of their builders to the utmost.

It is most fortunate that these reservoirs provide enormous storage at relatively low cost, otherwise their construction would not be feasible, as the irrigated land could not bear the expense of the costly structures of the East with their limited storage capacity. The Croton dam, if it had been constructed in Salt River Valley in Arizona for irrigation, would only supply 23,000 acres, and irrigators would have to pay $330 an acre for stored water, as against $20, the estimated cost from the Roosevelt dam.

Obviously, the cost figures cited have abso-

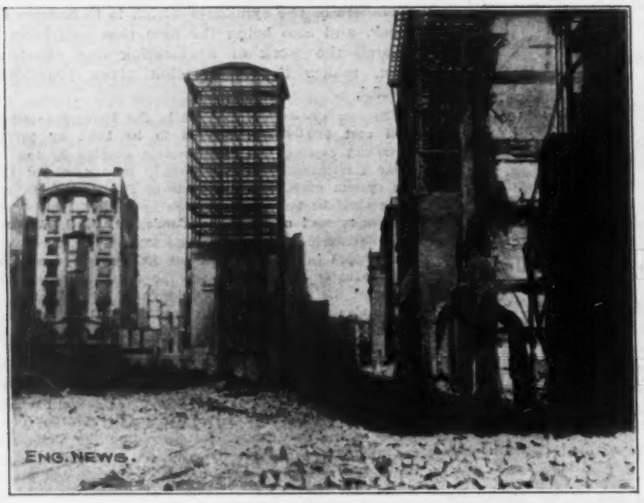


FIG. 3. VIEW ALONG GEARY ST., SHOWING UNFINISHED 15-STORY BUILDING.

FIG. 4. VIEW SHOWING HAYWARD BUILDING, WITH MERCHANTS' EXCHANGE ON RIGHT.

FIG. 5. VIEW EAST ON GEARY ST., SHOWING PALACE HOTEL AND MONADNOCK, MUTUAL BANK AND CHRONICLE BUILDINGS.

Fig. 6. Ruef Building in Course of Construction.

FIG. 1. GENERAL VIEW OF OFFICE BUILDING DISTRICT AFTER EARTHQUAKE AND FIRE.

FIG. 2. ST. FRANCIS HOTEL AFTER EARTHQUAKE AND FIRE.
(The two upper sections of the monument at the left were displaced about 1 inch.)

lutely no significance, in themselves, as regards the relative cost of construction work in the West and the East, except in so far as that the natural dam sites available in the West were far more favorable than those in the East for impounding immense volumes of water at low cost. We have not figured out the relative costs of masonry per cubic yard, for none of the Western dams are yet completed, and, in each section of the country, the gross costs include other than masonry work, as we understand it. As unit storage costs, however, and as comparisons of some of the other features of the six dams, the figures are of unusual interest.

THE RECENT EARTHQUAKE IN CENTRAL CALIFORNIA AND THE RESULTING FIRE IN SAN FRANCISCO.

By J. D. Galloway,* M. Am. Soc. C. E.

At 5.15 a. m. Wednesday, April 18th, the central portion of California was shaken by a severe earthquake, which wrecked a number of buildings in San Jose, San Francisco, Santa Rosa and Oakland, beside doing some damage in other towns. The earthquake was followed by a fire in San Francisco, which burned for three days and entirely destroyed the manufacturing and business sections of the city, together with about one-half of the residence section. An area of four square miles was burned over. As the portion of the residence section burned included the poorer quarters of the city and that containing the large family hotels, the number of people actually made homeless numbered possibly 200,000. These people are now being cared for by charitable organizations in the adjacent cities of Oakland, Alameda and Berkeley; and supplies are being received from all parts of the world.

The only other recorded earthquake shock of relatively great intensity in California was that of 1868, and the opinion is general that this last shock was much more severe. At the present writing, (April 29) but little is known of the money damage, but in San Jose, Palo Alto and Santa Rosa most of the brick buildings were destroyed. In these two cities the buildings were all of cheap construction, brick walls with timber floors, and not over three stories in height. The loss of life was considerable, but will probably never be accurately known. Possibly 350 people were lost in San Francisco.

*Oakland, Cal.

The shock was severe in Stockton and Sacramento, but no damage of note was done. In the mountains where a number of power plants

Fig. 3. Effect of Earthquake only on a San Francisco Church.

are situated there was only a slight tremble, and no damage whatever was done. The San Leandro dam, near Oakland, which was quoted by the Consulting Board of the Panama Canal as a precedent for the dam at Gatun, passed through the earthquake unharmed in any way. The writer has this information from Mr. Arthur L. Adams, M. Am. Soc. C. E., Consulting Engineer for the Contra Costa Water Co. No report of any kind concerning the concrete dam of the Spring Valley Water Co., near San Mateo, has been published, and the inference is that it is intact.

There is nothing to indicate the force of the earthquake at San Leandro, except that the damage to small buildings there was about as at Oakland, eight miles away. In Oakland, railroad tracks on filled ground were displaced, coal bunkers, sheds and factories on the same ground were wrecked, residence chimneys overturned and the brick walls of buildings thrown down. At San Jose and Santa Rosa the damage was greater.

In San Francisco the earthquake damage was greatest. San Francisco is an old city, at least old enough to have the majority of its buildings of old style construction—brick walls and wooden floors. By the building ordinance, buildings were divided into classes, those for business being A B C. Class A buildings were those with a steel frame supporting the walls and with concrete or terra cotta floors. Of these buildings there were about 30, varying from 8 to 19 stories, and with four or five exceptions they are the only buildings now standing in the burned district. Class B buildings were limited to eight stories in height. They generally had cast-iron or steel columns in the interior, and these, with the brick walls, carried the floors made of wooden joists. Class C was about the same as Class B.

It was the Class B and C buildings which were wrecked in the earthquake, causing the

FIG. 4. EFFECT OF EARTHQUAKE ONLY. A BUILDING OF WRETCHED CONSTRUCTION.

Fig. 5. View on Mission St. during Conflagration. Rialto and Grand Opera Burning.

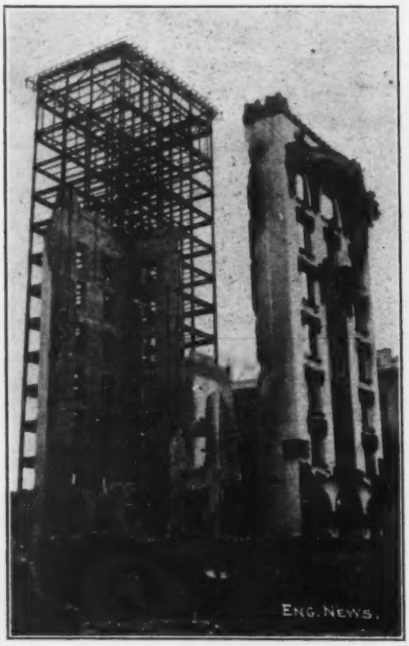


Fig. 6. Effect of Earthquake and Fire on a Class B Building. Steel Frame of Another Building in Course of Construction.

loss of life and setting fire to the city in various places. They constituted the main part of the city, including factories, warehouses and private hotels and all of them were destroyed by fire and earthquake. The brick walls pulled away from the timber joists and fell outward. On all buildings a wall was carried above the roof a few feet and designated the "fire wall." This wall fell down on almost all buildings, and was one of the most destructive agents in the loss of life. Among all of these buildings were scattered old frame structures, which were a constant menace to the better buildings.

The fire started in several places immediately after the earthquake, and it was found impossible to control it, as the shock had broken the water supply conduit from San Mateo and also the water mains throughout the city. Dynamite was used but with little success until the third day, when the fire had practically burned itself out.

The question the engineer would ask immediately is, what was the earthquake effect on structures? As far as known, dams are uninjured. On the Santa Fe railroad a bridge pier sank enough to delay trains a day. The only other class of injured structures, excepting sewers and water pipe, the damage to which cannot now be stated, were the large buildings of San Francisco, and as far as earthquake damage was concerned it could be called insignificant in all but a few cases. Two effects could be noticed. The buildings all seemed to have lurched forward and back which action split and crushed a stone here and there on corner piers at the first story. Above, at a height of about two-thirds of the entire height from the ground, there were diagonal cracks crossing each other and running from the intersection of a column and spandrel girder to a similar point on another floor. The buildings seemed to have vibrated back and forth as a whip is shaken, and where the node occurred the piers and walls were cracked as described.

FIG. 7. HALL OF JUSTICE ST. EFFECT OF FIRE AND EARTHQUAKE.

In San Francisco the building ordinance was a hodge podge of obsolete rules which permitted about any kind of construction and prohibited the use of reinforced concrete except for floors. As usual, some buildings of Class A were of

Fig. 9. Entrance to Fairmount Hotel. Granite Spalled by Fire.

flimsy construction, and in one or two cases they will probably be taken down. The old Chronicle and the Mills and Crocker buildings were constructed a number of years ago. The old Chronicle had cast iron columns and a part is badly wrecked. The other two mentioned are intact, structurally. Buildings such as the Merchants' Exchange, Kohl, Call, Mutual Savings Bank, Shreve, new Chronicle and Atlas, which are high as compared with their base, were all wind braced, either by diagonals, portal or knee braces. With the exception of some cracked plaster, splintered lintels and the points noted above, the buildings were intact as far as observation could or can tell. No distortion of the Atlas building occurred, the writer having examined it. Several engineers saw the buildings after the earthquake and noted these points.

There were but few instances of reinforced concrete construction except in floors, and these stood well. The rear portion of the Academy of Sciences was a seven-story structure built with columns, girders and floors of reinforced concrete on the Ransome system. It was built nearly 20 years ago. The walls are of brick and are badly cracked. It is impossible at present writing to examine this building. Another building with columns and floors of concrete but with brick walls was in course of construction, being three stories high. Under a wooden temporary office which burned, the concrete is stripped from the rods in the beams. Otherwise the concrete is intact, but the brick walls are shattered.

The deductions drawn by the writer from the earthquake effects are as follows: Brick in lime mortar is sadly discredited. In fire walls, gables and sides of buildings it fell out. In steel buildings it cracked and crushed. Possibly if laid in Portland cement mortar it would be better. The building with brick walls and wooden floors is, as built here, the most unsubstantial and dangerous construction. One exceptionally well built structure, the Folger building, passed through the ordeal of earthquake and fire without

FIG. 8. EFFECT OF EARTHQUAKE AND FIRE ON A CLASS B BUILDING.

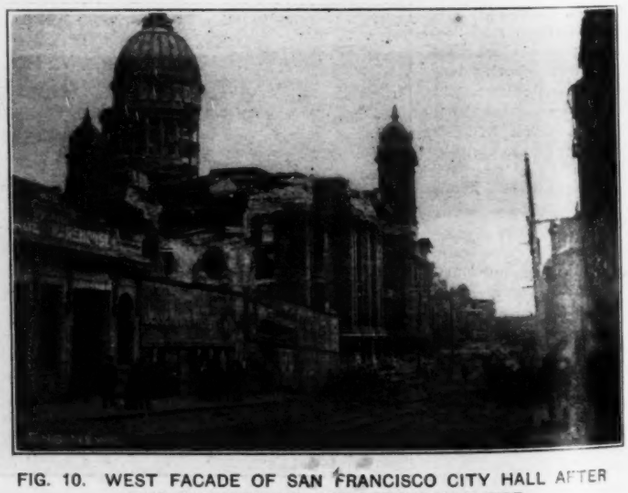


FIG. 10. WEST FACADE OF SAN FRANCISCO CITY HALL AFTER THE EARTHQUAKE AND BEFORE THE FIRE.

damage, but the great number were completely destroyed. The provision of the law which allowed an isolated wall 60 ft. high of 17 in. brick on top of which was another 60 ft. of 13 in. brick is a bad feature. One such was torn away from the steel frame and must be taken down.

Based on observation, the writer would say that a building for earthquake countries should have a steel frame with deep spandrel girders riveted to columns with knee brace gusset plates. In the interior all girders should be the same. Buildings of a height greater than the least dimension of the base, should have diagonal or portal bracing designed for wind at 30 lbs. per sq. ft. All walls should be carried at each floor, and if of brick, should be laid in Portland cement mortar. Mullions should have an angle running from girder to girder. Walls could be made of reinforced concrete, say 6 ins. thick, the reinforcing to be attached to the spandrel girders. For fireproofing all columns should be cased in solid concrete, reinforced and bottom flanges of beams and girders cased with at least 3 ins. of concrete. Wire lath and plaster or pieces of terra cotta are useless in a bad fire. Brick houses are a menace to life. Although many wooden houses were wrecked, there was no loss of life in them.

The great damage was due to the fire which burnt out every building, some floors of the Kohl being excepted. The fronts were of four kinds of material—granite, sandstone, pressed brick and terra cotta. The granite and sandstone spalled badly. The terra cotta spalled badly and also crushed in keystones, mullion caps, etc. Pressed brick was in no case exposed to a severe fire, but it stood well in all cases where used.

As far as performance is concerned, granite, sandstone and terra cotta are equally worthless. A fire caused by the burning of an ordinary office with the wooden floor seems sufficient to ruin the material around the windows.

Concrete floors do not seem to have suffered as far as observed. Terra cotta floors have the bottoms of the sections split off in a large number of cases. In the Mills building a number of safes fell through a number of floors. Almost all partitions failed, the ones of solid plaster standing up best. The terra cotta partitions must be taken down, but wire lath and studs can be replastered.

A detailed investigation of the fire effects is not possible at the present time, but the above embody general conclusions which will probably be verified by later examinations. As far as the earthquake is concerned, all of its results are evident. Red common brick is a material that should be excluded from construction in countries subject to earthquakes. The earthquake effect was less severe on the high buildings than the writer expected. On account of the construction it was expected that spandrel walls would fall out, but none did so. Here and there a cornice stone broke off. This is in marked contrast to the all-brick building, where outside the limits of the fire, churches were crushed into masses of brick, wooden dwellings upset and factories destroyed. Minor earthquake occurrences can be noted. The section of the city next the bay is on filled ground and this sank as much as 3 ft. in places. Wooden sheds on the piers were overturned and wrecked. The ground opened in a few places. Many residences were wrecked by sinking and distortion of the ground.

Had it not been for the fire the larger buildings could have been occupied that day without inconvenience, but the fire ruined all. Had the city been supplied with a salt water system it might have saved the greater part of the city.

The work of rebuilding is now contemplated, and will go forward as soon as the destitute people are provided for.

It must be recognized that the above statements are preliminary only. With the exceptions of foundations, the earthquake damage to buildings is known. Only a detailed examination can determine the fire damage. When this is done, the writer hopes to offer a more studied account of the damage done.

FIG. 11. THE CITY HALL AFTER THE FIRE.

A SUPPLEMENTARY REPORT ON THE SAN FRANCISCO BUILDINGS BY PROF. DERLETH.

Sir: Your telegram of April 22 reached me five days thereafter. I could therefore not comply with its requests. We have all been so busy out here that it has been impossible to do everything required.

I have not yet been able to visit the two large earth dams of the Spring Valley Water Co., but so far as I can learn from very reliable sources, they are in excellent condition. I have already told you that all the earth dams of the Contra Costa Water Co., supplying Oakland, have been undisturbed by the earthquake. The destruction of the San Francisco water supplies occurred in the main conduits and pipes on soft and filled ground. It was in these same regions that the sewers were generally broken.

Careful examination of the high Class A skeleton steel construction buildings shows that many of them have earthquake cracks but not of a serious nature. I am not led to change any statement regarding high buildings made in my letter of April 24.

I told you in my first short note of April 23 that there are no buildings in San Francisco with outer walls of reinforced concrete. All the reinforced concrete work is found as floor slabs, floor beams and interior columns.

There has always been successful objection to the construction of a complete reinforced building. A few reinforced retaining walls may be found. A wall over 30 ft. in height came to my notice about two months ago and was to have been constructed. I shall look into these matters. Examination of reinforced floors and columns lead me to believe that they resisted the earthquake splendidly, but this statement does not mean much because earthquake destruction was not usually manifested in those parts of buildings; besides examples of this work are relatively few.

In my letter of April 24 I unfortunately made some statements which are in error. The California Electrical Co.'s building on Folsom St., between Second and Third, does consist of brick walls but has no steel columns and girders on the inside; neither are its floors of timber and cement. The interior construction is first-class mill building design. The floors are of 2 × 6-in. joists, without spacing, with an oak surface. The columns are of timber. These floors helped to give consid-

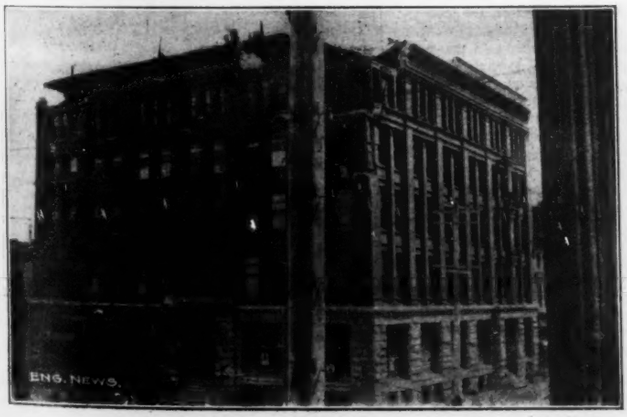


FIG. 12. VIEW IN OAKLAND. EFFECT OF EARTHQUAKE ON A CLASS B BUILDING.

FIG. 13. VIEW IN OAKLAND. EFFECT OF EARTHQUAKE ON AN OLD BRICK BUILDING.

erable lateral rigidity to the structure. The errors mentioned are of no moment because they do not affect the conclusion which I emphasized. Not only are the windows of wire-ribbed glass, but the frames are of metal. The glass was very much cracked and in some places even started to melt, but none of these windows gave way. Curtains on the inside charred and fell to powder. The roof tank has a capacity of 50,000 gallons and the tank in the cellar holds 120,000 gallons. This building was saved by its windows and water supply, but like all buildings of its type, it was considerably, although not seriously, damaged by the earthquake. The top brick walls and cornice were very generally thrown down. I have already stated that the chimney was cracked at its base and must be removed. In addition to this, the north wall under the chimney and elevated tank has

Fig. 1. View Taken Some Ten Years Ago.

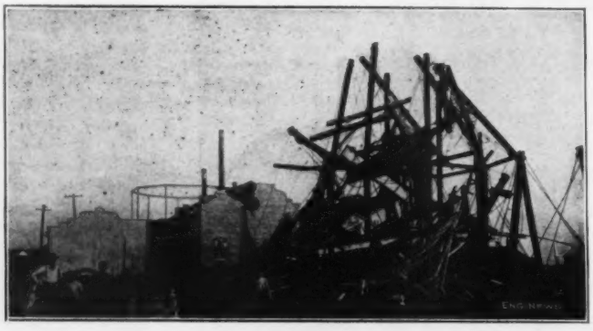


FIG. 2. VIEW OF THE WRECK.

FIGS. 1 AND 2. EFFECT OF EARTHQUAKE UPON WATER TANKS AND TOWER AND GAS WORKS, SANTA CLARA, CAL.

been generally cracked and will have to be replaced. Some of the interior wood columns under the chimney and tank have also been injured by splitting along the grain. This building was provided with a fire system of automatic sprinklers with electric connection, but it was not used. I believe it did not work.

At this time it is dangerous to make general statements, but I know they will be received with the proper spirit. It is only by discussion and criticism that we can gain the most from this great structural disaster. I therefore give the following tentative conclusions as matters for discussion:

1. Heavy cornices of brickwork should be avoided in San Francisco in the new buildings.

2. Terra cotta and similar materials should not be so profusely used. Such materials were cracked badly by the earthquake, as is seen on the north wall of the Fairmount Hotel, and they do not seem to have stood the fire well; certainly not so well as light-colored pressed brick.

3. Wooden buildings and cheap brick structures should be discouraged in the business section of the city.

4. Where brick buildings are used without steel work, they should be of small height, three to four stories at most, the bond of brick work should be carefully inspected, the floors securely tied, and the walls and the foundations designed with the greatest care.

5. Heavy stone towers and steeples, or the same structures in brick work, should be discarded as far as possible, and when they are used they should be greatly strengthened with steel and by interior walls.

6. Important buildings should not be built on old swamps and made ground, as for instance, near the water front at Market St.; near the post-office at Mission and Seventh Sts., and in the region of Valencia and Howard Sts., between 18th and 19th Sts.

7. On made and soft ground, foundations must be built with greatest care.

8. Reinforced concrete should be more respected in the future by the building laws and trade unions of San Francisco.

9. Low buildings of this type of construction would seem to me far better than cheap brick buildings which were so generally crippled or entirely thrown down by the earthquake.

10. On soft ground, for low buildings, footings and foundation walls and cellar slabs might be made of reinforced concrete.

11. Reinforced concrete sewers instead of brick ones deserve study and consideration.

12. Heavy concrete footings generally should be used instead of brickwork.

13. For brickwork a little cement would do no harm in the lime mortars of the future and a good deal of cement would be still better.

14. Poor cementing material and brick, in my judgment, had much to do with the earthquake destruction of the city hall.

15. In soft ground important water pipes might be built in tunnels and be of riveted steel with flexible joints. The cracking of the tunnels might still save the pipes due to the properties of the metal, the nature of the joints and the air space between the tunnel walls and the pipe. Such a construction would further give access to the pipes in case of calamity.

16. Important pipes might be in duplicate and the city divided into sections of hard and soft ground, the network of pipes being arranged accordingly.

17. High chimneys should be reduced to minimum height and be carefully reinforced. A study of reinforced concrete chimneys should be made; also forced draft versus high chimneys.

18. In the business section Class A buildings should be encouraged at the expense of Class B structures. Skimping of steel frames should meet with entire disapproval. Cast-iron columns should not be used.

19. Heavy stone ornamentation should be used with caution and heavy weights upon centralized supports, as in the Flood building, should be avoided when possible.

20. Buildings over twelve stories in height would to me seem unwise except upon suitably firm ground. The firm areas of the city have been well marked by the present earthquake.

21. On soft ground, pile foundations have given excellent results.

22. Granite and sandstone have been chipped and spalled dreadfully by the fire.

23. Marble has not been cracked by the fire to the same extent as granite and sandstone.

24. Concrete has stood the heat splendidly.

25. Metal window frames, metal shutters, venetian blinds and wire-ribbed glass windows should be more fashionable in the future.

26. Important buildings should have roof tanks or cellar tanks, or both, for water storage, with pumps.

27. San Francisco should have more wide streets like Van Ness Ave.

28. Belgian block pavements spalled miserably from the fire.

29. The business district should be safe-guarded by a salt water fire system which, for additional protection, might be of flexible pipe in tunnel, since it must traverse soft and made ground. The city needs a better fire boat service.

30. Gas main explosions, due to the fire, have in many places caused big rents in the streets. Perhaps gas mains should not be near important water pipes.

31. A study of the destruction of heavy stone buildings at Stanford University must teach important lessons.

32. A careful study of the Kohl building when compared to the ruins of surrounding structures, will be a valuable contribution to engineering knowledge.

33. The effect of heat and cooling upon the steel frames of high buildings in the regions of fiercest fire will be an equally important study.

34. I suggest also a careful investigation of the Appraisers' Building, corner Washington and Sansome Sts., Palace Hotel, St. Francis' Hotel, Call Building, Monadnock Building, Chronicle Building, Flood Building, Mills Building, Crocker Building, and many others, together with typical Class B structures, many of which latter have been alsmost entirely destroyed.

35. A study of the Ferry Building, its foundations and towers and an examination of the Hall of Justice, corner Kearney and Washington Sts., should be made. The City Hall structure should be investigated.

Professor Charles Gilman Hyde, who holds the Chair of Sanitary Engineering at the University of California, is primarily investigating the sanitary and municipal aspects of the disaster, while the undersigned is paying more particular attention to structural problems. We are taking up this work for the Department of Civil Engineering at the University of California and hope eventually to write a complete and joint report after sufficient time has elapsed and a complete study and investigation has been made. The Department of Civil Engineering will greatly appreciate suggestions from all sources, which may be sent either to Professor Hyde or myself.

Very truly yours,

C. Derleth, Jr., C. E.,
Associate Professor of Structural Engineering.
University of California, Berkeley, Cal., April 29, 1906.

EARTHQUAKE EFFECTS AT SANTA CLARA, PALO ALTO AND SAN JOSE, CAL.

By C. E. Moore.*

Possibly a few earthquake observations from the center of the disturbance may be of interest to your readers. I take the first moment of leisure since the shake-up on April 18 to write a few notes. My home is in the little town of Santa Clara† (population 4,000). The town is supplied with water, gas and electricity from municipal plants. The water is supplied by pumping. In order to avoid continuous pumping and also to take the place of a stand-pipe for equalizing the work, there were provided four tanks, carried by a steel tower 80 ft. high.

At the time of the earthquake I happened to be at home, and I immediately devoted myself to the task of getting the municipal plants in operation, all being more or less wrecked. The tower was wrecked, breaking the supply main under it. A temporary by-pass was rigged up and in a few hours the town was again supplied. The brick power-house was badly shattered, and I feared that the roof trusses would fall, which would entirely lay out the plant. Timber was immediately procured, and a row of braced columns placed under the ends of the trusses.

The first shock was at 5.15 a. m. Slight tremblors were felt all day, and at 2.30 p. m. there was a shock which would ordinarily have been reported as severe. By that time we had the power-house roof quite well secured, and although more brick wall came down no damage resulted. The bracing was carried on until the roof was entirely supported independently of the crumbling brick walls.

Attention was then given to the gas plant. Not a chimney in town remained in a fit condition to be used, and nearly all were cut off at the roof line, while many were demolished throughout. Consequently to avoid danger from using chimneys, it was important to re-establish the gas service as soon as possible, this being generally in use for cooking. In this plant some pipes were

Fig. 3. Steel Water Tower and Tanks at County Hospital, San Jose, Cal., Uninjured by Earthquake.

broken, etc., but damages were comparatively small, and in a few hours the gas plant also was in operation.

The current for electric lighting is supplied from a long distance transmission line. As soon as the mass of tangled wires could be straightened out the transmission line was ready to deliver current, and in three days the streets were again lighted, and incandescent lights were in

*Civil and Consulting Engineer, Santa Clara, Cal.
†Santa Clara is about three miles northwest of San Jose and 47 miles southeast of San Francisco.

use in the houses which were in a condition to occupy.

In addition to the above activities I have been serving on a committee to pass upon the safety of buildings in this vicinity. Consequently, I feel that I have been acquiring some valuable data regarding the structures which will resist earthquake strains and those which will not.

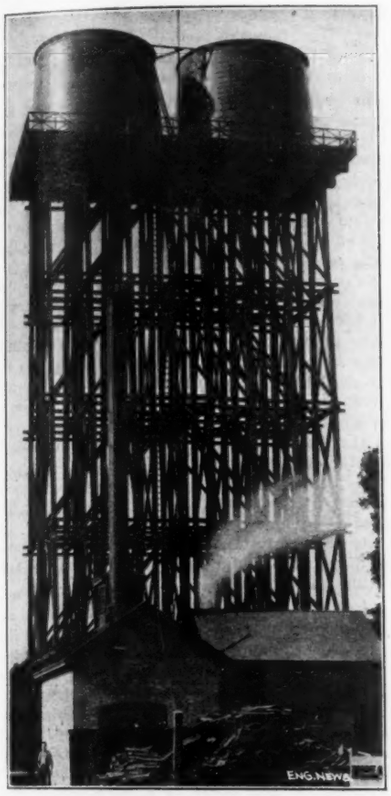


Fig. 4. Timber Tower Supporting Water Tanks at Palo Alto, Cal.

(Uninjured by earthquake, although surrounding buildings were rendered uninhabitable.)

For the present I will only say that all brick buildings were more or less damaged, many were totally demolished, and many more will have to be in great part reconstructed. Many frame houses were practically demolished.

Regarding the water tower above referred to I will give some additional facts. (See Fig. 1 for view of tower and tanks, taken some ten years ago.) At the time of the shake-up there was a load of 120,000 gals. of water in addition to the structure. The structure swung to the south until the top was probably 6 ft. or more out of plumb. It then went to the north an equal distance. It then recovered itself and stood upright for several seconds. By that time the quake was practically over, and the engineer of the plant, who was watching it, concluded that the tower would stand after all. Two of the tanks, however, had been thrown to the south. First they were projecting about half their width off from the floor. Then at another vibration they shot off and struck the ground about 75 ft. away. The other two tanks had also been thrown to the south, striking the floor about in the middle. After the tower had righted, two remaining tanks slowly settled through the floor, and in falling of course struck the tie rods. These two tanks lie in a pile near the center of the tower. I enclose a photograph (Fig. 2) which I think tells the story quite plainly.

The floor supporting the two water tanks consisted of 15-in. I-beams, resting on plate girders. It appears that the plate girders turned partly over from the impact of the tanks, which were thrown violently to the center. Under this strain the rivets began to give way and finally the floor fell through. The lower left hand corner of Fig. 2 shows about the point where the two tanks thrown off struck the ground. I think there is evidence of considerable vertical motion. Apparently only such a movement could have thrown these tanks around as was done. I think I have evidence of the same movement in other structures.

The small and unfortunately defective photograph of two water tanks supported on a steel tower (Fig. 3) is of particular interest, because although this structure stands unharmed the buildings surrounding it were rendered uninhabitable. This water tower, which was designed by me, was located at the San Jose County Hospital. The lower tank has a capacity of 50,000 gals. and the upper of 30,000 gals., and the floors supporting the tanks are 45 and 90 ft., respectively, above the ground level. I also enclose a photograph (Fig. 4) of a timber tower which I constructed several years ago for the Palo Alto water-works, near Stanford University, and which came through unharmed. The tower is 98 ft. high, to the floor line, and the tanks have a combined capacity of 90,000 gals.

Reverting now to conditions in Santa Rosa. About 1½ miles from the water tower in that city there is a crack in the ground about 3 ft. wide at the top and about 20 ft. deep. A few hundred feet from the tower a man driving across the field in a buggy yesterday (April 28) struck an impassable morass, where before he had driven many times, and before discovering it had driven so far into it that the horse was with difficulty got out.

Finally, there is a unique story to be told about the Methodist church in Santa Rosa. The view (Fig. 5) was taken about 10 a. m. of the day of the earthquake. At 2.30 p. m. of the same day the church trustees had gathered around the dilapidated structure and were discussing ways and means of getting the tower down without endangering adjacent buildings. While they were talking the second shock came and the problem was immediately solved by the tower crumbling in a heap.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AT CHATTANOOGA, TENN.

The city of Chattanooga, in the southeastern corner of Tennessee, is locally called the Gateway of the South. Perhaps the facts back of this title had influence in determining the American Society of Mechanical Engineers to hold its semi-annual meeting this year in the metropolis of the fertile Tennesse Valley. Certain it is that the society has never had any very extensive membership in the South, and that if it desires to go into that country on a proselyting campaign it needs a suitable gateway. But the scenic and historical charms of Chattanooga are more than sufficient attraction to draw a summer convention [and will be more strongly so when the city shall be better provided with hotel facilities]. They were sufficient to bring a strong, representative attendance to the meeting of the American Society of Mechanical Engineers, held at Chattanooga last week. Nearly 200 members and guests registered; less than 10% of these were from the South, the others coming from northern points an average distance of 600 to 800 miles to attend the meeting. This fact, in connection with two others, speaks strongly for the virtues of Chattanooga. These two other facts are that the meeting included very little technical work and that, in spite of this fact, those in attendance at the meeting went home satisfied with the week spent at Chattanooga.

An interesting circumstance connected with the meeting was that, as the society itself has only two members in the city, half a dozen engineers of other affiliations joined with them in making the local arrangements and were equally active with them in bringing the meeting to successful issue. This affords a hopeful example of engineering solidarity, a condition by no means universal in American cities.

The meeting was held during the four days Tuesday, May 1, to Friday, May 4, 1906. As customary with this society, the first day consisted only of an evening meeting at which no business or technical work was transacted. At this meeting Mayor W. L. Frierson of Chattanooga welcomed the society in a polished speech, wherein he characterized the engineer as the dominant man of the present age, the successor of the soldier and the statesman who in their respective epochs marked out the line of advance. A brief response by President F. W. Taylor (Philadelphia, Pa.) closed this first session. Two professional sessions followed, on the mornings of Wednesday and Thursday respectively. A reception and dance on Wednesday evening contributed the usual social tone. The remainder of the time of stay was occupied—and very fully occupied—by sightseeing trips.

The vicinity of Chattanooga, with its great battlefields at Chickamauga, Lookout Mountain and Missionary Ridge, all within a radius of six miles from the city, offers abundant historical interest. The scenic charms of the region are equally great. The three available days, insufficient for more than a hurried round of visits, were fully utilized for seeing as much of the region as possible. On Wednesday afternoon the society traveled up Lookout Mountain. On Thursday afternoon a trip was made by trolley-car and tally-ho through the National Park, 10 square miles in area, on the battleground of Chickamauga; a cavalry drill by the troops stationed in the park added to the war taste which this visit gave. The return from this trip was made along the crest of Missionary Ridge, a four-mile drive along the position held by Bragg in 1863 while Grant's army was in Chattanooga.

Fig. 5. Methodist Church, Santa Rosa, Cal., Between First and Second Severe Shocks.

Friday was employed for two main trips of interest, the first to a double-track tunnel being built by the Southern Ry. through the northern end of Lookout Mountain, the second by steamboat down the river to Hale's Bar, where a concrete dam, lock and electric power plant are being built by the Chattanooga & Tennessee River Power Co. The latter trip gave

a panorama of picturesque mountain country that was not the least enjoyed feature of the meeting. The Lookout Mountain tunnel is a double-track tunnel, 28 ft. wide, 3,800 ft. long between portals, most of which lies in a dense rock requiring no lining, while several hundred feet are in soft and broken rock which requires full timbering during the excavation and a complete lining. The lining will be of concrete up to the springing line of the roof arch, the latter being of brick. The solid-rock part of the work, the west end, is notable because it is being driven by bottom heading, and this heading is being taken out the full width of the finished tunnel, giving a heading about 7 ft. high by 28 ft. wide.

Only two items of society business came before the meeting. The first was the proposal of an amendment to the constitution, moved by Mr. C. W. Hunt (New York, N. Y.), which aims to add to the list of standing committees a Research Committee. The proposed amendment will come up for action at a future meeting. The other was a move to put the society on record as favoring forest preservation for conserving the waterpowers of the country. Mr. Calvin W. Rice (New York, N. Y.) moved that the council be directed to consider what action to this end is advisable, and to take such action. The motion was carried.

Technical Proceedings.

Ten professional papers and two reports of technical committees were presented at the meeting. Two of the papers, namely "A Low Resistance Thermoelectric Pyrometer and Compensator," by Prof. W. H. Bristol (Hoboken, N. J.), and "A History of the Introduction of a System of Shop Management," by Mr. J. M. Dodge (Philadelphia, Pa.), had been presented during the past winter at local meetings of the society in New York. The former of the two was again read at Chattanooga, and was discussed, but no additional information was brought out. The other papers received no discussion of moment. In particular, the series of papers on Regulation of Water-Wheels, which was intended to be the principal subject of deliberation at the meeting, was not discussed at all; no time was available for discussion, as the afternoon trip to the Chickamauga battlefield demanded prompt adjournment of the morning session.

The two committee reports received somewhat more courteous treatment. The Committee on Standards for Small Machine Screws, which presented its first report at the annual meeting of December, 1905, had slightly revised its recommendations in the interim and presented them as a revised report. Several communications in discussion of the report, announced by the Secretary, advanced divers criticisms of the recommendations. Criticism was directed at the committee's list of standard sizes, the form of thread, the sizes and forms of heads, and the form of thread-gage (ball-end micrometer gage). While these criticisms emanate from important machine-screw interests, they appeared to be as diversified as the sources from which they came. They served to show clearly, however, that the desirable close approach to agreement among the machine-screw interests and the committee has not yet been reached. The meeting therefore ordered the committee to consider its recommendations further and report again at the winter meeting.

A final report was submitted by the committee appointed by the society to cooperate in the Pennsylvania Railroad Company's locomotive tests made during and after the Louisiana Purchase Exposition of 1904. The report recites briefly the scope of the tests in question, and gives their results in condensed form. Mr. E. G. Bailey (Fairmont, W. Va.), in discussion, criticized several details of the tests, particularly the procedure used for determining the amount of heat supplied to the locomotive in coal. The coal used was of an unusually uniform kind, yet the calorimeter tests and analyses show variations of 7% in ash and 12% in calorific value. The latter variation in particular is improbable, and it seems that more correct values would be obtained by averaging the tests of all samples and applying the result to all individual tests.

AN ATTEMPT TO MEASURE KINETIC ENERGY IN STEAM HAMMERS.

A paper entitled "The Effect of a Blow" was presented by Messrs. A. W. Moseley and J. L. Bacon (Chicago, Ill.). The authors employed steel plugs of known quality to measure the energy of steam hammers. The plugs, ½-in. diameter by ½-in. long, were calibrated by compressing them under various loads in an ordinary testing machine, and noting the length after compression. By plotting the test loads as ordinates on compression as abscissa value, a stress-strain curve was obtained. The area under this curve represented the work required to compress the plug. By planimetering the curve to various abscissa values, and plotting the work as ordinate on compression as abscissa, a work-strain curve was obtained which represented the energy consumed in slow compression. To obtain a similar curve for rapid compression, i. e., for a blow, a 200-lb. steam hammer was employed; the cylinder was removed and the piston-rod packing loosened to minimize friction losses. By raising the hammer known amounts and dropping it on a plug of the same size as used before, known amounts of kinetic energy were expended on the plugs, and the compression produced by the blow could be plotted against kinetic energy. By comparing the resulting curve with the work-curve for slow compression, it was found that the compression by hammer involved a loss of about 32% over slow compression; that is to say, 145 ft.-lbs. kinetic energy were required to produce the same compression in a given plug as would be produced by 100 ft.-lbs. effective work between the platens of a static testing machine.

It is important to note that in the static tests the test-plug was compressed, released, measured, again compressed, released, measured, etc. In the hammer tests, on the other hand, a separate plug was used in each blow, and thus no effect of repetition of stress is included.

The authors conclude that the method used by them furnishes a means for measuring the kinetic energy of a blow, and a reliable basis for rating hammers and similar machines.

Prof. D. S. Jacobus (Hoboken, N. J.) remarked that the authors assume the ratio of lost work to be independent of speed of blow and length of plug. In his opinion this assumption is not reasonable, in default of experimental proof.

THE COLLAPSING PRESSURE OF STEEL TUBES.

A remarkably extensive piece of research work was reported in summarized form by Prof. R. T. Stewart (Allegheny, Pa.) under the title "Collapsing Pressures of Bessemer Steel Lap-Welded Tubes 3 to 10 Ins. in Diameter." The research was made for the purpose of determining the strength of steel tubes under external pressure, and to establish formulas, tables and diagrams expressing the variation of strength with diameter, thickness and length of tube. The main part of the research comprised two series of tests:

Series I.—This series of tests was made on tubes that were 8⅝ ins. outside diameter, for all the different commercial thicknesses of wall, and in lengths of 2½, 5, 10, 15 and 20 ft. between transverse joints tending to hold the tube to a circular form. The chief purpose of this series of tests was to furnish data for determining which of the existing formulas, if any, were applicable to modern lap-welded steel tubes, especially when used in comparatively long lengths, such as well-casing, boiler tubes and long plain flues.

Series 2.—This series of tests was made on single lengths of 20 ft. between end connections tending to hold the tube to a circular form. Seven sizes, from 3 to 10 ins. outside diameter, and in all the commercial thicknesses obtainable, were tested. The chief purpose of these tests was to obtain, for commercial tubes, the manner in which the collapsing pressure of a tube is related to both the diameter and thickness of wall.

The results of the first series showed two things: first, that length was of practically no influence on the strength provided the tube is longer than about six diameters; second, that every known formula for the collapsing strength of tubes is radically incorrect. From the results of both series, the author deduced the following formulas, of which the first is for values of P less than 581 lbs. per sq. in. (or t ÷ d less than 0.023), and the second is for values greater than these:

$$P = 1{,}000\left(1 - \sqrt{1 - 1{,}600\,\frac{t^2}{d^2}}\right)$$

$$P = 86{,}670\,\frac{t}{d} - 1{,}386$$

where P = collapsing pressure, in pounds per square inch.
d = outside diameter of tube in inches.
t = thickness of wall of tube, in inches.

The paper describes quite fully the apparatus for and the procedure of the experiments. Shaw differential-piston mercury gages were used to measure the pressure. Each tube was calipered at every foot of length by an autographic calipering apparatus, which yielded a diagram, to a ten-fold scale, of the out-of-roundness. Some 6,000 of these diagrams were taken in the course of the research. It was later found that the position of the (longitudinal) weld was of little influence on the location of the axis of the collapse; that the location of the thinnest point of the wall at the section of collapse was of recognizable influence; but that the out-of-roundness was of very distinct influence, since in a large majority of the tests the collapse took place at the section showing maximum variation of diameter and the axis of collapse coincided with the least diameter of this section.

The paper, though in itself but a condensed summary of the research, is far too extensive for reproduction here. We hope, however, to print an abstract of its main results in another issue. The discussion of the paper on the floor of the meeting was negligible.

A NEW FORM OF WATER METER.

Mr. G. B. Willcox (Saginaw, Mich.) presented a paper entitled "A New Liquid Measuring Apparatus," which described a water meter of novel design used for measuring continuously large flows of water (or other liquid). It was used originally for measuring brine flowing from a salt well, and was next put to use for measuring boiler feed water.

Essentially, the meter is a tank which discharges by a siphon when a definite amount of water has accumulated in it; but its distinctive features of novelty are two auxiliary devices which make the action accurate. Above the main tank is a preliminary storage tank, into which leads the pipe carrying the liquid to be measured. An opening in the bottom of this preliminary tank allows the liquid to pass directly into the main tank, while the latter is filling. At the moment when the main tank has filled to the discharging point, the outlet of the preliminary tank is closed, and the flow is then retained by this tank until the water in it reaches a height enabling it to overflow a suitable pipe and pass into the main tank. The rise of water in the main tank, by this overflowing, raises a float and drops the water stored in the preliminary tank into the main tank. Thereafter the supply flows through the preliminary tank directly into the main tank until the latter again reaches the discharge height. The preliminary tank thus prevents unmetered flow while the siphon is discharging.

The means used for starting the discharge of the main tank are interesting, as they secure a positive discharge at a very closely-fixed point. The discharge pipe has a downward loop, leading from the siphon of the main tank; the drop leg of the siphon can thus contain air under pressure, up to a head of a few feet. Connected to the air space of this leg is a smaller pipe, called the "trip," which also contains a downward U-bend half filled with water, and the farther riser of this bend has an atmospheric discharge at a fixed level above the lowest point of the bend. The action of the device is thus: as water rises in the main tank, it creates a pressure in the air-space of the siphon, and hence also in the drop leg of the siphon. This pressure forces the water in the U-bend of the "trip" up into the riser leg; when this water reaches the overflow

or discharge level of that leg, the pressure of the air confined in the siphon can no longer increase, but vents itself around the U-bend of the trip and up to the atmosphere. The diminution of pressure in the siphon causes the water in the tank to surge up into the siphon, whereby the latter discharges quite suddenly.

The action of the siphon "trip" is utilized to close the outlet valve of the preliminary tank just at the moment the main tank discharges. The discharge siphon is of the concentric type, but the outer hood, instead of being fixed, has a small range of rise and fall, and by means of a vertical rod extending upward it can actuate the preliminary tank outlet valve. When the main tank is empty, the siphon hood is unsupported, hence is in its lowest position and holds the preliminary tank outlet valve closed down on its seat. When the preliminary tank overflows, the accumulation of water in the main tank gradually floats the siphon hood upward, until the uplift is sufficient to enable it to raise the outlet valve off its seat. The preliminary tank then discharges into the main tank and the latter fills, producing air-pressure below the hood of the siphon as already described. When the tripping point is reached, this air-pressure is suddenly released, and the siphon hood falls by its own weight, thereby at once closing the preliminary tank outlet valve and permitting no more water to enter the main tank.

The apparatus is provided with a float in the main tank, operating a totalling counter to record the number of discharges. The exactness of measuring obtained by the meter evidently depends upon the amount of water contained in the U-bend of the trip at the end of each discharge. It is stated by the author that a boiler-feed meter of this type, whose main tank is 48 ins. in diameter by 42 ins. deep, showed a maximum error of less than 0.25 %. Some modifications in construction to adapt the meter to hot water are described in the paper.

In discussion it was questioned by Prof. D. S. Jacobus whether the small error quoted by the author includes the effect of varying rate of flow. Some dependence of the registration upon velocity of flow is to be expected, and if this is all included in the ¼% quoted it is a remarkable showing of precision.

POWER AND NAVIGATION IMPROVEMENTS ON THE TENNESSEE RIVER AT HALE'S BAR, TENN.

There is now under construction at Hale's Bar on the Tennessee River, 12 miles southwest of Chattanooga and 33 miles (by river) downstream, a concrete dam, lock and power-house, which will provide slackwater navigation through the steep "mountain section" of the river and at the same time yield about 40,000 HP. electrical power. The work is being done by the Chattanooga & Tennessee River Power Co., under general designs (for the lock and dam) of the War Department. A paper by Mr. Thomas E. Murray (New York, N. Y.,) on "The Improvement of the Tennessee River and Power Installation of the Chattanooga & Tennessee River Power Co. at Hale's Bar, Tenn.," described the work projected and now in execution.

The desirability of improving the river in this region has long been recognized, but many successive Army Engineers' reports united in showing that the improvement for navigation alone would not be worth its cost. Through the efforts of Chattanooga engineers, notably Mr. J. C. Guild, the possibilities of an improvement for both navigation and water power received thorough study. As a result, in 1904 Congress passed an act, amended later as to location of the works in question, which authorized the Secretary of War to grant permission to the City of Chattanooga to build a lock and dam in the mountain section of the river, under his direction; and failing to arrange with the city within four months from passage of the act, he was empowered to offer the franchise to C. E. James and J. C. Guild of Chattanooga; failing to contract with them within eight months, he was empowered to contract with any private person or corporation for the construction of the works. The party of the second part in any case was to construct the entire works at its own expense, except the lock machinery which was to be furnished by the government; the utilization of water for power was required not to interfere with the flow of water or navigation of the river, and power for operating the lock was to be furnished from the plant free of charge. The company's franchise is for ninety-nine years.

This act is the first instance of cooperative action between the government and private parties in the construction of river improvements. It is expected to furnish a model for other undertakings of like character.

The work includes a concrete dam 1200 ft. long and 65 ft. high above foundations, giving a head on turbines of 39½ ft. at low water and 19 feet. at extreme high water. The power-house, also of concrete, adjoins the dam and forms its prolongation. Beyond the power-house an earth embankment with concrete core-wall, 700 ft. long, closes the flat side of the valley. The lock, located along the rock bank of the river opposite the power-house, will be 60 ft. wide, 300 ft. long, and 6 ft. deep on the miter sills. The top of the lock walls will be at an elevation 15 ft. above the crest of the dam. Each leaf of the lower gate will be about 34 ft. long by 59 ft. high and will weigh about 129 tons; each leaf of the upper gate will be about 26 ft. high and will weigh about 50 tons. The power-house will contain fourteen units, each comprising three turbines on a vertical shaft carrying a 3000 KW. generator at its upper end. The fact that the effective head will be minimum at flood-time and maximum at time of minimum discharge, makes necessary the use of reserve wheel capacity in each unit; it is planned to use two of the three turbines at ordinary stages, and all three at times of flood. A transmission line about 12 miles long will conduct the generated power to Chattanooga; the design of this part of the work has not yet been definitely decided.

The discussion of the paper gave occasion for the motion to put the society on record in favor of forest preservation as noted earlier in this report. Mr. W. T. Donnelly (New York, N. Y.,) commended the cooperation between the government and private authorities on which the project is based, and pointed out that the entire work was rendered possible only by the long, thorough study of the river by the government engineers. Mr. F. W. Taylor (Philadelphia, Pa.), also commending the cooperative feature, cited the Fox River, in northeastern Wisconsin, as a flagrant instance of lack of cooperation between the government and private persons interested in the river; large manufactures, dependent on the water power of the river, are seriously affected by the fact that government engineers insist on maintaining navigation, although the river carries practically no traffic other than pleasure boats. Major H. C. Newcomer, Corps of Engineers, U. S. A., and Mr. J. C. Guild also spoke. Mr. Guild called attention to the fact that the lower gates of the Hale's Bar lock will be the highest lock gates in this country.

WATER-WHEEL REGULATION AND EFFICIENCIES.

An excellent series of papers on the control of water-wheels, and one paper on turbine efficiencies, were presented to the meeting. The former series contain perhaps a clearer summary of the problems and difficulties of water-wheel governing than has yet been given in print. Several forms of governor are described in connection with the statement of the problem, and the main forms of gate or speed-changing element for pressure turbines, impulse turbines and tangential wheels are described. The nature of the papers makes it impossible to summarize their contents. We give, therefore, a mere statement of the ground covered by each paper, reserving the presentation of fuller abstracts for a future date.

Mr. M. A. Replogle (Akron, O.) presented "Some Stepping Stones in the Development of a Modern Water-Wheel Governor." The paper stated in striking manner the complex functions which must be performed by a water-wheel governor when the load on the wheel changes, and expressed the opinion that a governor of purely mechanical nature (i. e., without hydraulic or electric elements) offers the best means of solution. The principles of the "Lombard-Replogle" governor, which has as its essential element a spherical variable-speed friction gear, are then described.

A paper entitled "Speed Regulation of Water-Power Plants" was presented by Mr. John Sturgess (Troy, N. Y.). The effect of the inertia of the mass of water in the penstock, which acts in opposite direction to the governor whether the latter opens or closes the gates, is given special prominence of this paper. The oscillatory action of a governor, that is, on rise of load opening the gate farther than required for the new load and then after a short interval moving the gate back a trifle, is then explained, and its value in securing quicker adjustment to the new-load condition is pointed out. The author says "The most successful governors are of the hydraulic class." Several diagrams of governor action illustrate this point.

In a paper on "Turbine Design as Modified For Close Regulation," Mr. G. A. Buvinger (Dayton, O.) describes the usual forms of turbine gates and some details of gate-operating mechanism. The influence of the inertia of the penstock water also receives some discussion.

A paper by Mr. G. J. Henry, Jr. (San Francisco, Cal.) deals mainly with the speed-changing or "gate" element of tangential impulse water-wheels. The simple slide-gate, the needle-nozzle, and the deflecting nozzle are discussed in this paper, and some attention is given to the governing of deflecting nozzle impulse-wheels operated in parallel, where special care is necessary to prevent unequal distribution of the load. A hydraulically-operated relief valve for protecting the penstock is also described and illustrated.

In a paper on "Efficiency Tests of Turbine Water-Wheels," Mr. W. O. Webber (Boston, Mass.) gives the results of complete efficiency tests made on four different turbines of the high-power or so-called "American" type. Brake tests were made at different gate-openings and different speeds. The tests appear to have been made at Holyoke. One wheel showed a maximum efficiency of about 89%, at 144 r. p. m., 23 ft. head, delivering about 275 HP. As the brake was on a geared jack-shaft, an allowance of 5% to the brake horse-power is made to give the wheel horse-power. The method of computing the water consumption is not stated. The other three wheels gave maximum efficiencies of 69%, 72% and 75% respectively.

These papers were not discussed, due to lack of time at the meeting.

NEW BIDS FOR THE MANHATTAN BRIDGE over the East River at New York City were opened by the Commissioner of Bridges of New York City on May 7. Six bids were received, but one was withdrawn. The five others were:

Ryan & Parker Construction Co.	$6,493,223.00
John Pierce Co.	6,596,638.30
General Erecting Co.	6,769,983.00
Milliken Brothers	7,566,191.65
American Bridge Co.	8,312,146.00

These bids are on the new plans and specifications, abstracted in our issue of April 19, 1906, p. 445, which were gotten out after the 1905 call for bids (and proposed contract) had been declared illegal by the highest court of the State of New York. The lowest bid on the 1905 specifications was $7,284,739, by the Pennsylvania Steel Co. As shown by the above list, the lowest of the new bids is nearly $800,000, or 11%, lower. The new bids were to have been opened on April 30, but a temporary injunction was obtained by a taxpayer which forbade opening the bids. After argument in court on May 5 this injunction was vacated and the bids were opened as noted. There is now a further taxpayers' injunction pending against the Commissioner of Bridges, which restrains him from entering into contract for the construction of the bridge. This injunction alleges that the call for bids and the proposed contract are wasteful of public moneys, because sufficient consideration has not been given to an alternative plan for building the bridge, namely, the plan of employing, in place of wire cables, chains made up of eye-bar links. This injunction recalls the famous controversy of four years ago over the design to be adopted for the Manhattan Bridge.

GAS IN THE SHAFT-HOUSE, over the shaft, at 15th St., Jersey City, N. J., of the New York & Jersey Railroad Co., leading down to the tunnels under the Hudson River to Morton St., New York City, overcame 18 workmen as they were preparing to enter the tunnels Wednesday morning, May 2. The elevator was waiting to lower the men to the headings of the tunnels, which are being extended landward into Jersey City to connect with the railways, when there suddenly burst through the surface of the ground a short distance from the shaft a sort of geyser of smoke, gases and cinders. The shaft-house quickly filled with gases, which first caused the men to laugh, then to become unconscious. The origin of the gases is thought to be due to leaks of an old sewer and carbon monoxide gas resulting from incomplete combustion of carbon. All the land in that vicinity is "made ground," the Delaware, Lackawanna & Western R. R. having used it for a cinder dump. These cinders have been slowly burning for the last two years and it is supposed that the compressed air used in the tunnels had forced an opening through the walls of the tunnels and acted upon these smoldering ashes as a bellows, causing the generation of gas with the above results.

A COLLAPSE OF THE STEEL FRAMEWORK of the Fat Stock Show Building, under erection at Landsowne Park, Ottawa, Ont., occurred on April 23, injuring 16 workmen. Six trusses and their supporting columns were wrecked. From the account sent us by our special correspondent it appears that all the trusses fell to the west, or at right angles to their length. The easterly truss was erected first, and guyed both to the north and the south. All the trusses were fastened together by horizontal beams, three between each pair of trusses, on which beams the roof was to have rested. The design called for heavy diagonal beam braces from the top of one column to the bottom of the next, in each outer row of columns. Owing to delays in shipment this bracing had not arrived and erection was proceeding without it. The westerly truss and supporting columns was braced to the west by timbers; a 10 × 10-in. against one column and a lighter timber against the other. At the time of the accident planks were being raised to form a scaffolding, apparently by means of a pulley, fastened to one of the trusses. The primary cause of wreck is not known with certainty, but it appears that the pulley failed to work and that some planks fell against and loosened a guy wire, causing the trusses to sway. The wind was blowing strongly from the east at the time, or against the timber braces at the westerly pair of columns. Both these timbers were snapped in two. In the wreck, the columns were bent over, in the form of arches. The bases of these columns were drift-bolted to concrete bases, not one of which broke or even cracked, and only two or three (all on the south side) of which were moved out of plumb. The men at the top of the steelwork jumped as the latter neared the ground, but some of those below were caught in the wreckage. This is the third wreck the building has suffered, each of the former wrecks having been attributed to "snow on the roof." The first wreck was on Jan. 25, 1904, and, our correspondent states, was doubtless caused by "faulty construction." Four men were injured. The second collapse was on Jan. 19, 1905, when the building was nearly completed. Five trusses, supporting the roof, fell at 2 p. m., and at 10 p. m. three more followed, leaving only five trusses standing. No one was injured. The building was torn down after the second wreck and a new contract let for a steel and concrete building. The concrete bases, however, were built by the city of Ottawa. The contractor for the work that was wrecked on April 23 was the Locomotive & Bridge Co., of Montreal.

A SMOKE-NUISANCE CONVICTION was obtained by the Board of Health of New York City on May 7 in proceedings against the New York Edison Co., whose large Waterside plant was the offender. It was shown by testimony that cinders and soot emitted from the chimneys of the plant had caused specific long-continued inconvenience and injury in the neighborhood. The defendants alleged insufficiency and unconstitutionality, but the court decided against this contention and found a verdict of guilty. Two other smoke offenders pleaded guilty after the first case was decided. One of these originally made a plea of not guilty, and asserted that there is no way of burning soft coal without producing smoke. Professor W. Kent, of Syracuse, N. Y., as expert, testified that soft coal, as well as any other fuel, can be burned smokelessly provided the furnaces are properly constructed and provided due care in firing is employed. It has hitherto been very difficult, or impossible, to secure smoke-nuisance convictions in New York City, as judges have repeatedly held the view that specific injury must be proven to make the ordinance applicable. Procedure by Board of Health orders prohibiting production of smoke have been more effective, but as such orders employ the very extraordinary powers with which the Board of Health is invested for the purpose of enabling it to combat dangerous disease, the health authorities have disliked to use them against the less vital sin of emitting dark smoke.

THE THREE CHICAGO RIVER TUNNELS at Chicago will have to be lowered to give the increased navigable depth in the river as required by the government. The La Salle St. and Washington St. tunnels belong to the city, and the City Engineer, Mr. Ericson, proposes to first build a new flat roof about mid-height in the tunnels, supporting it on the side walls. The original arched roof would then be broken in and removed (probably by dredging), and the work of excavating to the new grade and putting in the new floor and lower sections of side walls could then be done without much trouble. The Van Buren St. tunnel, which is the largest of the three, is owned by the Union Traction Co., and the courts have decided that the company must undertake the work of lowering it.

PERSONALS.

Mr. D. C. Webb, Civil Engineer, U. S. N., has been ordered to the Naval Station, Key West, Fla.

Mr. John A. Hanlon, of Coshocton, O., has been elected Engineer of Construction for the improvements to be made on the Ohio canal from Akron to Dresden, O.

Major Edward Burr, Corps of Engineers, has been assigned to duty as Engineer of the First and Second Lighthouse Districts, relieving Col. Wm. S. Stanton, Corps of Engineers.

Mr. Joseph Shea has been appointed Water Supervisor, in charge of water supply and water stations, of the Chicago, Rock Island & Pacific Ry., with headquarters at Topeka, Kan.

Mr. Heinrich J. Freyn has resigned as Engineer of the Gas Engine Department of the Wellman-Seaver-Morgan Co., Cleveland, O., to accept a position with the Illinois Steel Co., South Chicago, Ill.

Mr. L. D. Blauvelt has been appointed Assistant Chief Engineer of the Colorado-Utah Construction Co., who are building the Denver, Northwestern & Pacific Ry. His headquarters are at Denver, Colo.

Major C. S. Riche, Corps of Engineers, U. S. A., assumed, on May 1, charge of the district which includes River and Harbor Improvements of Illinois River, Rock River, and the Illinois and Mississippi (Hennepin) Canal. All correspondence concerning the same should be addressed to him at 504 Federal Building, Chicago, Ill.

The following changes have taken place in the Reclamation Service: Mr. H. G. Graham has been appointed Assistant Engineer and assigned to hydrographic duty with John E. Field on North Platte Project. Mr. Geo. A. Reed has been appointed Engineering Aid and assigned to duty on Klamath Project. Mr. H. W. Sheley, Engineering Aid, has resigned from the service.

A committee on the reconstruction of San Francisco was appointed by Mayor Schmitz on May 3. Among its members are the following engineers: Thos. P. Woodward, City Engineer; Major Chas. H. McKinstry, Corps of Engineers, U. S. A.; Edwin Duryea, Chief Engineer Bay Cities Water Co.; Marsden Manson, Consulting Engineer; Virgil Bogue, Chief Engineer Western Pacific Ry. Advisory members are Messrs. D. H. Burnham, John Galen Howard and Benjamin Ide Wheeler.

Mr. G. K. Gilbert, Geologist, member of the United States Geological Survey, who has been engaged for several months making hydraulic experiments in the mining laboratory of the University of California, at Berkeley, has been instructed to make as thorough a study as possible of the phenomena of the recent earthquake in California. Mr. Gilbert is well fitted to carry on this investigation, as he has devoted much thought and time to seismological problems, besides being one of the most experienced geologists connected with the Survey, having been a member since its organization in 1879. He has published numerous articles on geology, glaciology, earthquakes, etc., and his researches have often taken him to the Sierras of California, so that he is thoroughly familiar with the geologic history of that state.

Mr. William A. Baldwin after 55 years of railway service has retired as President of the Cleveland & Marietta Railway Co., having reached the age prescribed by the rules of the Pennsylvania System for retiring. Mr. Baldwin began his career by serving 8 years under Mr. John C. Trautwine and entered the service of the Pennsylvania Railroad in 1858. He remained with this company for 43 years, advancing from Clerk to the Superintendent of the Western Division, to Assistant Engineer, to Superintendent of the Western Division of the Philadelphia & Erie R. R., to Assistant General Superintendent of this road, to General Superintendent, to Assistant General Manager of the Pennsylvania Company's Lines, to General Manager, to President and General Manager of the Buffalo, Rochester & Pittsburg Railway Co., to President and General Manager of the Cleveland & Marietta Railway Co., resigning as General Manager in 1900.

Obituary.

Col. Henry H. Adams died at his summer home at Greenwich, Conn., May 7, as the result of an operation for the removal of his leg. He was born at East Cleveland, O., in 1844 and was well known in military circles and in the iron and steel business, having been President of the Old Sterling Iron & Mining Co., Algomah Copper Co., Adams Crucible Steel Co. and other companies.

Charles L. Spier, M. Am. Soc. M. E., was killed at his home in New Brighton, Staten Island, N. Y., May 7, aged 40 years. He was well known, having been Mr. H. H. Roger's confidential man and President of the Richmond Light & Railway Co., Staten Island Midland Railway Co., Sea Coast Traction Co. and Yeoman Transmitting Typewriter Co. He was also Vice President, Secretary and Treasurer of many other companies. It has not been definitely determined as yet whether Mr. Spier was shot by a burglar, whom he was seeking, or whether he accidentally shot himself.

Prof. Israel C. Russell, head of the Geology Department of the University of Michigan, died at Ann Arbor, Mich., May 1, of pneumonia, aged 54 years. He was a graduate of the University of the City of New York and the Columbia School of Mines, and was Assistant Professor of Geology in the Columbia School of Mines, 1875 to 1876. Prof. Russell was a member of the United States expedition to New Zealand in the early seventies, to observe the transit of Venus, and the United States Coast and Geodetic Survey expedition to Alaska, 1879. He also headed expeditions to Mount. St. Elias region in 1890 and 1891, in the course of which he made explorations in an entirely unknown country, obtaining much information regarding the geography and glacial geology of the country.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 22 to 24. Annual meeting at Chicago, Ill. Secy., W. H. Merrill, Jr., Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 28 to June 1. Annual convention at Milwaukee, Wis. Secy., Ralph W. Pope, New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 5. Annual meeting at Atlantic City, N. J. Secy., W. C. L. Eglin, 136 Liberty St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 5 to 7. Annual convention at Cleveland, O. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 658 Rookery, Chicago, Ill.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 21-23. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 26. Annual convention at Thousand Islands, N. Y. Secy., Chas. Warren Hunt, 220 West 57th St., New York, N. Y.

AMERICAN WATER-WORKS ASSOCIATION.
July 10 to 14, inclusive. Annual meeting at Boston, Mass. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 19 to 20. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 23 to Aug. 4. Joint meeting with the Iron and Steel Institute at London. Secy., R. W. Raymond, New York City.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago on May 2, a paper by Mr. R. E. Milligan on "The Development of Mechanical Filtration" was read, but the author was not present. In the discussion, Mr. J. W. Alvord pointed out that something more than the mere installation of a filter plant is required if effective results are to be obtained. Careful and skilled attention to the operation, and constant watchfulness as to the maintenance of the filter in proper condition are absolutely essential. Mr. D. W. Mead remarked that while much has been done by the filter companies, engineers are not entirely dependent upon them, but can develop many independent improvements of their own.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The twenty-third annual convention of the institute will be held at Milwaukee, Wis., May 28 to June 1. The meeting is to be held on these dates, instead of the later part of June as previously announced, so that members may attend both the annual convention and take part in the European trips if they so desire. Headquarters of the institute will be at Hotel Pfister, Wisconsin and Jefferson Sts. Some sixteen papers will be read before the convention by the following gentlemen: Mr. Maurice Milch, Mr. Chas. H. Bedell, Mr. Farley Osgood, Prof. E. E. F. Creighton, Mr. H. C. Wirt, Mr. Chas. P. Steinmetz, Prof. Chas. F. Burgess, Mr. Edwin F. Northrup, Mr. T. F. Morgan, Mr. Edwin J. Prindle, Mr. W. L. Waters, Mr. David B. Rushmore, Prof. Dugald C. Jackson, Mr. Joseph Bijur and Mr. Charles M. Heminway. Secy., Ralph W. Pope, 95 Liberty St., New York City.

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